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ENGINEERING AND
Mining Journal

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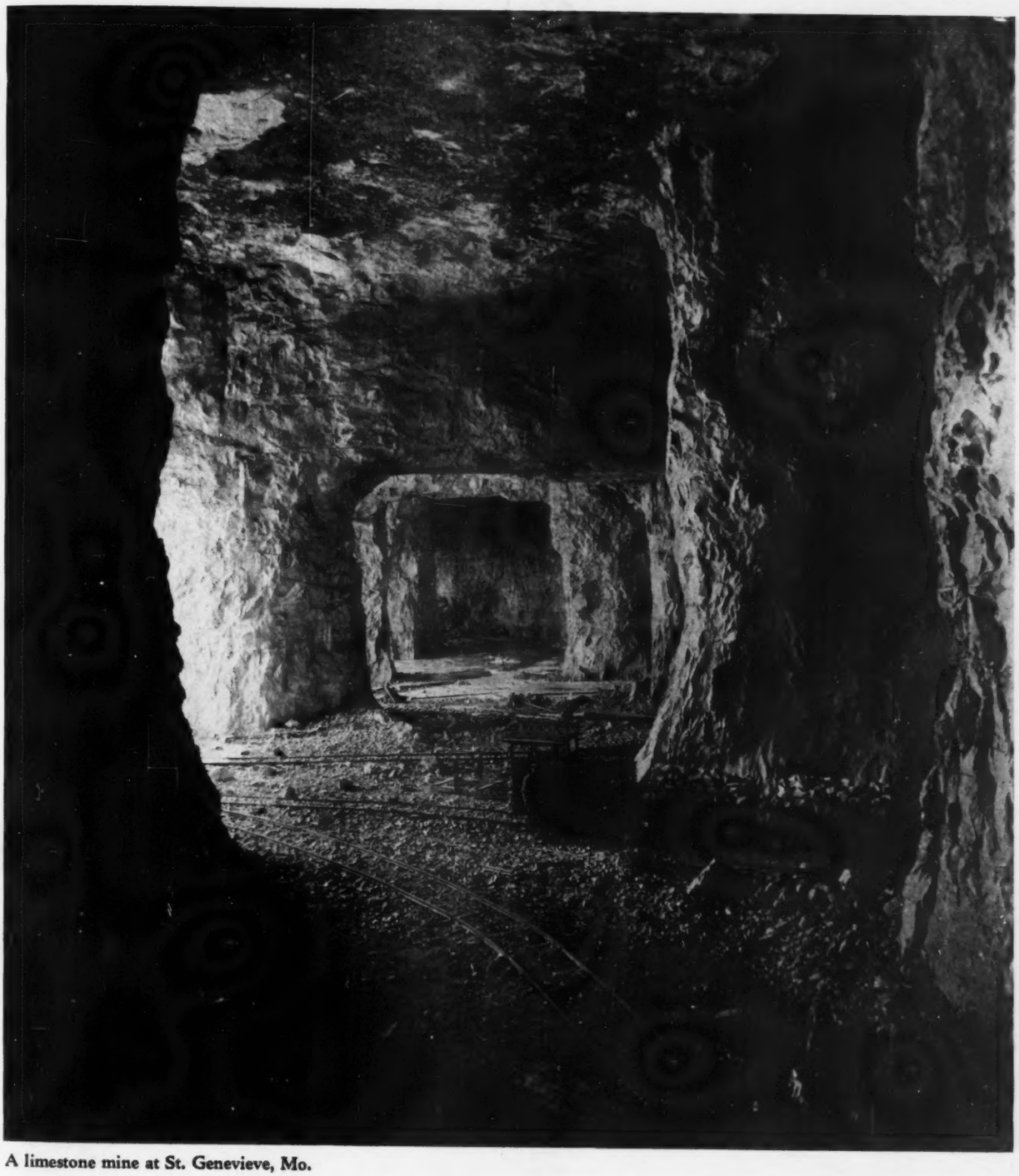

A limestone mine at St. Genevieve, Mo.

May 8, 1930

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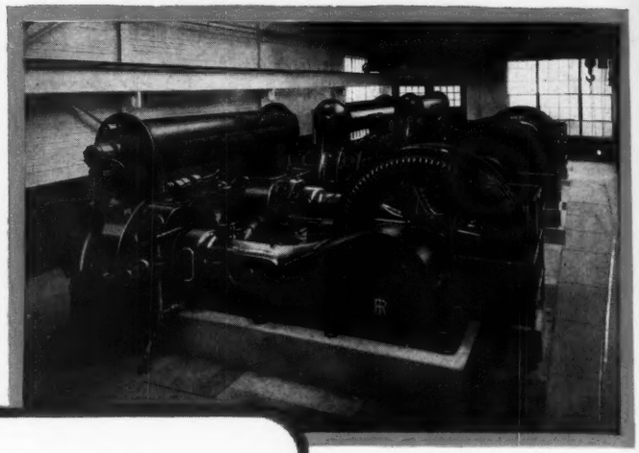

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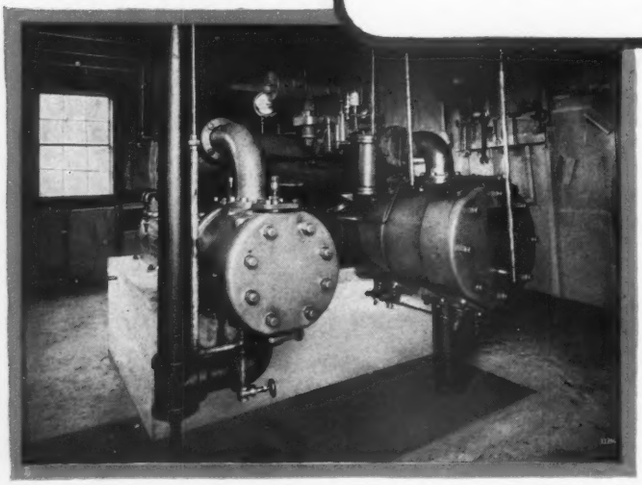

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A McGRAW-HILL PUBLICATION

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VOLUME 129 . . . NUMBER 9

Editorials 437
The Tariff on Silver . . . . A Plea for Uniformity in Measurements Units . . . . A Social Center for Mining Engineers in New York . . . . "What Is Not Yet May Be."

Ore Hoisting in the Butte District. Part I 441
HARRER and FARNHAM

"Manitoba Metal" 446
R. H. CHANNING, JR.

The Problem of Roasting Blende 448
DR. GEORGE BALZ

Gradient Chart 451
SYDNEY C. MIFFLEN

Non-Metallic Minerals in Canada 452
M. F. GOUDGE

pH Value in Flotation 458
H. L. HAZEN

Change: Its Significance 459
E. J. MEHREN

Mine Transport of Limestone 462
RALPH W. SMITH

Phosphate in North Africa 465
ERIC B. TOWNSEND

Zinc in the Southwest 467
OLIVER C. RALSTON

Digest Current Literature 468
Industrial Progress 470
Personal Notes 474
News of the Industry 475
Cabled News 480
Market and Financial 482
Metal Statistics 487
Mining Stocks 488
Searchlight Section 73
Professional Directory 72
Advertising Index 80

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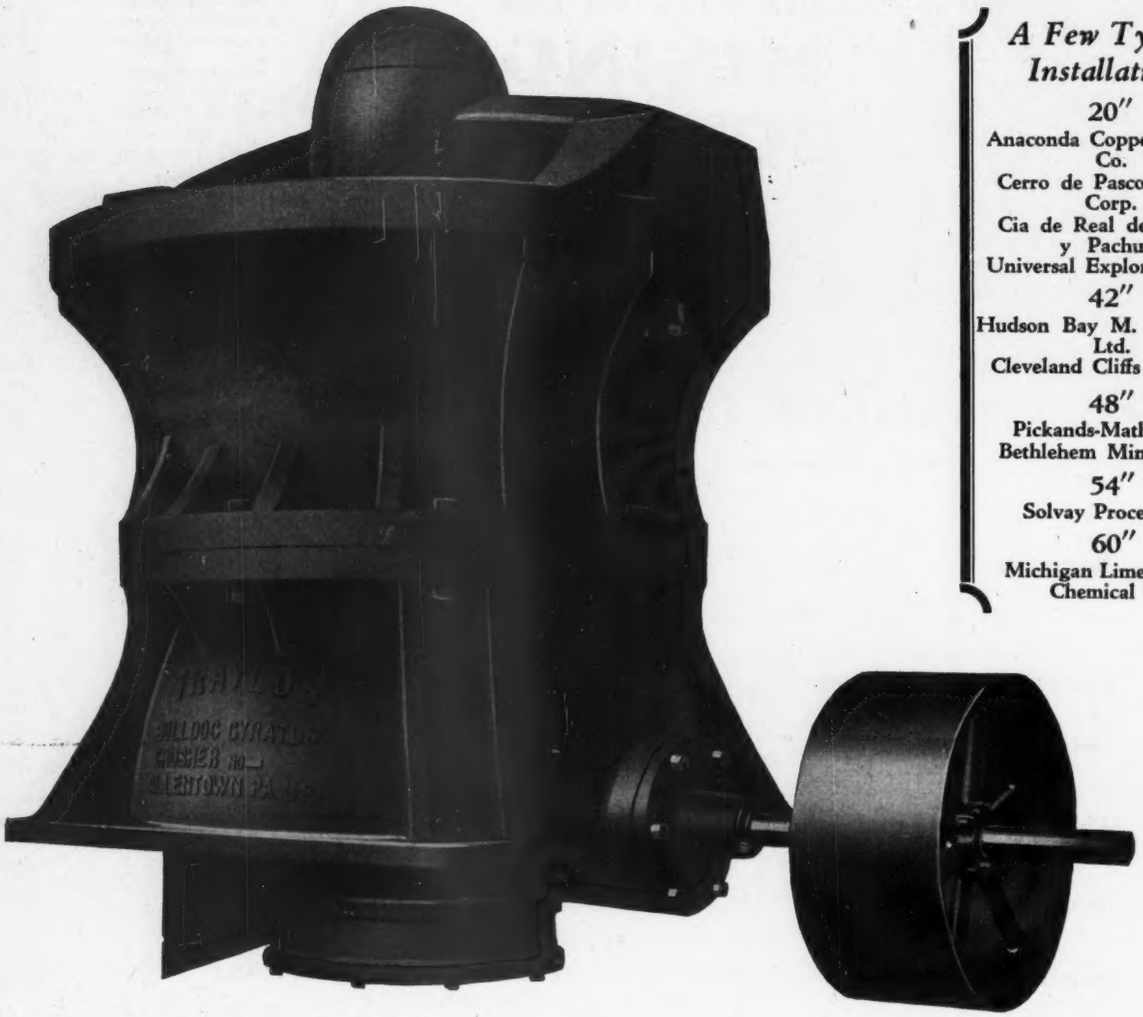

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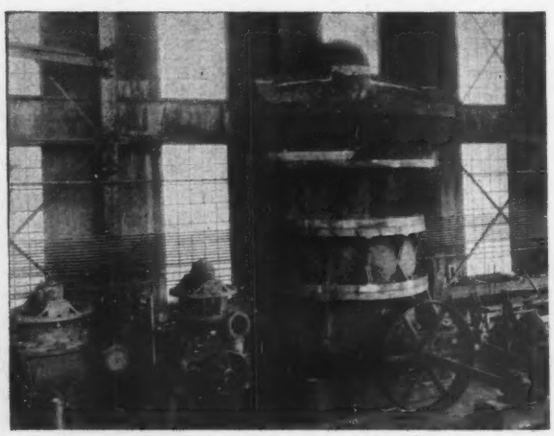

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ENGINEERING AND
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JOURNAL

A. W. ALLEN, *Editor*

VOLUME 129, NUMBER 9

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New York, May 8, 1930

The Tariff on Silver

THE price of silver—virtually an international price—averaged about 53 cents per ounce in 1929. Quotations reached a low of about 39 cents per ounce in 1930. The metal is now selling at about 42 cents per ounce, compared with a peak price of $1.37 following the War. Silver production in 1929, despite the low price, was about 260,000,000 ounces—probably the highest rate in the history of the industry. The reason for this increase is seen in the fact that silver is a byproduct from many base-metal operations. Production of all three major non-ferrous base metals—copper, lead, zinc—was at an unprecedented rate in 1929.

According to the United States Bureau of Mines, silver production in the United States in 1929 was 60,937,600 ounces. The highest point in recent years was reached in 1923, when 70,355,000 ounces was produced, but the proportion from silver mines was small. The following statistics refer to total production, compared with silver-mine production, of silver in the United States, 1920-29, inclusive:

	Total Output,		—Silver Mine Output—		Average Price
Year	Ounces	Value	Ounces	Value	per Ounce
1920	56,536,904	$57,100,000	20,477,612	$20,700,000	$1.01
1921	46,332,956	29,000,000	24,117,251	15,000,000	0.626
1922	61,207,989	40,500,000	26,631,579	19,000,000	0.675
1923	70,355,674	45,500,000	27,636,947	17,800,000	0.648
1924	64,070,744	42,600,000	20,388,065	13,700,000	0.667
1925	66,710,080	46,000,000	17,099,876	11,700,000	0.69
1926	62,487,219	39,000,000	13,567,095	8,400,000	0.62
1927	59,625,682	33,100,000	11,775,384	6,600,000	0.56
1928	58,462,507	34,011,000	12,000,000*	7,000,000	0.58
1929	60,937,600	32,540,000	11,000,000*	5,700,000	0.53

*Estimated.

The output from silver mines during 1928 and 1929 is not yet known, the amounts given being estimates only, which will probably prove high. The other figures given are on the authority of the United States Bureau of Mines.

This distinction between total silver production and silver-mine production must be realized. In 1927, copper ores produced 14,560,000 ounces silver; lead ores, 15,762,000 ounces; zinc-lead ores, 13,624,000 ounces. The remainder came from miscellaneous classifications. In all such operations silver is a byproduct. In some instances the revenue obtained from its sale is important, but rarely does it determine the scale of operations. A fall in the price of silver does not cause a lead mine to suspend operations unless the price of lead falls also. To make this clear, the following table, showing operating profit at six important Western silver-lead producers, has been prepared. Note that the total value of silver produced exceeds the profit at only one property. In other words, even though nothing were obtained for the silver output, and assuming that the prices of lead and zinc remained at a sufficiently high level, these mines could still operate at a profit:

		—Silver Production—	
Mine	Profits, 1929	Ounces	Value (Approximate)
Bunker Hill	$2,473,936	1,735,350	$860,000
Federal	2,682,806	1,703,299	850,000
Hecla	2,227,465	1,668,069	837,000
Silver King	2,038,654	2,993,193	1,500,000
Tintic Standard	1,628,115	2,986,212	1,500,000
Park Utah	577,028	2,759,678	1,400,000

Appreciation of the foregoing facts is a necessary preliminary to a discussion of the advisability or practicability of a tariff on imported silver. When such a tariff was recently proposed for the avowed purpose of protecting the silver mines, its sponsor must have been aware of the fact that the effect of the present low silver prices was disastrous only to mines the principal product of which is silver. Lead, zinc, and copper mines, although they would be helped by a silver tariff if it could be made effective, would continue to operate and give employment in spite of low silver prices. The main argument of Senator Pittman, who proposed such a tariff, was that the low price of silver was causing unemployment in the West, that the prosperity of entire towns and counties was being affected thereby. An examination of the table of production will show, in the first place, that the decline in the value of the output of silver mines has been extremely gradual. Miners who could no longer find employment in silver mines after the drop in price in 1926 must have been absorbed long since into other industries or into other branches of the mining industry.

Readers *of Engineering and Mining Journal* had a right to expect editorial comment on the practicability of the silver tariff. This publication deplores the present condition of the silver-producing industry, and would willingly lend support to any legislation that would, in its opinion, really foster the interest of the silver miner. But a study of the silver situation resulted in the accumulation of convincing evidence that a tariff can be of no avail. Even Senator Pittman, who proposed the tariff, admits that it may not increase the price of silver in the domestic market.

The United States consumes, at most, 40,000,000 ounces of silver and produces at least 20,000,000 ounces more than that. The Senator has spoken about the

present dumping of low-cost silver on the United States market from abroad, which his tariff is aimed to prevent. But can a commodity be dumped in any given market when the price is uniform throughout the world? Foreign silver is imported here for refining, but more than an equivalent amount is then marketed abroad. To make a silver tariff effective, silver production in this country must be almost equaled by consumption. That is an inescapable conclusion. *Engineering and Mining Journal* could have evaded consideration of this fact, it could have taken the easier path and remained silent or commended Senator Pittman's tariff. But to shut one's eyes to the truth is neither courageous nor constructive.

Engineering and Mining Journal therefore came to the conclusion that the Pittman silver tariff under existing conditions was probably not practicable. What induced the Senate to change its mind and pass the bill after having first defeated it? Few Senators are conversant with the mining industry. Senator Pittman advanced strong arguments in favor of his measure, but the following quotations from his speech before the Senate on March 19, with comments, indicate that incorrect impressions probably resulted:

"In the State of the Senator from Idaho, as he will realize, if he has been reading the newspapers, two or three large silver-lead mines have been closed down during the last few weeks."

This is correct. The mines were the Star, the Tamarack & Custer, the Sherman, and the Golconda, but not one of them suspended operations because of the low price of silver. The essential reason was the drop in the price of lead—a tariff-protected commodity—to 5.5 cents per pound, delivered in New York. To mention their closing in connection with silver prices is to give a misleading impression.

"In Utah, several important mines have closed down in the last week."

Although more than a month has passed since Senator Pittman made this statement, information from Utah indicates that only a few unimportant mines in the state have closed—within the past two weeks. Several are on a curtailed production basis.

"And one district in Colorado, which is purely a silver-mining district, where silver mines were working a month ago, two or three of them, employing thousands of men, have closed down."

This doubtless refers to Creede, the only "purely" silver mining district in Colorado. Its production in 1929 was 520,000 oz. of silver, worth about $270,000. Hardly more than 300 men could have been employed. *Engineering and Mining Journal* can obtain no evidence in support of Senator Pittman's contention that thousands of men have been thrown out of work there. In all Colorado, not more than 7,000 men are employed in mining. Silver represents hardly one-eighth of the value of the mineral output. The three largest enterprises produce molybdenum, gold, and lead-zinc-copper, respectively. All three are continuing operations at or near capacity.

"The mines there [Utah] have cut the wages of the men in the lead and silver mines . . . 25 cents a day and in the smelters 25 cents a day."

This statement also gives a misleading impression. Wage scales in Utah mines are based on the price of lead or copper. Silver does not enter into the calculation. If the price of silver increased 30 cents per ounce, and if lead remained at 5.5 cents per pound, the miners would receive no additional pay. Again:

"Practically every mining property in Tonopah, Nevada, is closed down."

Tonopah, owing to ore exhaustion, has been a dying camp for several years. Most of the properties passed the peak of production when silver was over $1 per ounce, and the decline in price is merely accelerating the process of their closing. Nevertheless, production is still about one-half of what it was two or three years ago. Tonopah Extension, still in operation, has been the second largest individual producing mine there for many years. To say that "practically every" mine has closed is misleading. On April 18, Senator Pittman said:

". . . there is not the slightest bit of doubt that it [the proposed tariff] will stop the dumping of silver into this country from India . . ."

This conclusion can be traced to a remark made by Senator Smoot, of Utah, during the debate before the vote on March 19. "As those silver coins come out of circulation," he said, referring to an alleged practice with metal currency in India, "they are melted and exported all over the world; but America is the principal place to which they are sent." This argument in favor of the tariff loses weight when the facts are known: According to statistics made available by the Department of Commerce, the United States since 1924 has imported a total of only 2,155 ounces of silver from India, none of which was in the form of silver bullion.

Engineering and Mining Journal therefore reached a decision that the information given to the members of the Senate in regard to the status of the silver industry of the United States was incomplete and capable of misinterpretation; and that a majority vote in favor of the silver tariff was, in consequence, partly due to misunderstanding. Under these conditions this publication could not evade its responsibility to its readers and to the mining industry.

The editorial in the issue of April 7, which stated that "*Engineering and Mining Journal* gravely doubts whether the tariff will accomplish its avowed end, or whether, even if it did, such a heavy tax on the consumer would prove desirable," occasioned an inflammatory attack on this publication by Senator Pittman, the sponsor of the bill. On this occasion the Senate of the United States was given the impression that *Engineering and Mining Journal* had been acquired during comparatively recent years for propaganda and lobbying purposes; that it had acted "viciously" and in a "low manner" to attack those who supported a duty on silver; that "the evidence in this matter indicates that this thing [the editorial criticized] was not only instigated but there was some compensation for it . . ."; that the editorial was a "low and hypocritical attack"; that, "Through this whole miserable thing is this hypocrisy, this propaganda, all originating with the vigilance committee of the Jewelers' Association . . . who are now basely, through a mining journal which has heretofore been respected by miners, attempting to defeat the very thing which every miner in this country, every mining association in this country, the Mining Congress of this country have stated is absolutely essential to prevent the entire destruction of the industry."

The final argument in Senator Pittman's speech will

be disposed of first and in a few words, by proving that he is mistaken in his impressions. The American Mining Congress has not advocated such a tariff, because, as was stated in an editorial in the January issue of its journal, "it does not believe that it would be of any value to the silver producer." Officials of the American Institute of Mining and Metallurgical Engineers are equally skeptical, as will be seen by an examination of the April issue of *Mining and Metallurgy*, the Institute publication. According to Mr. W. F. Boericke, of the Institute staff: "Obviously there can be little or no benefit for the miners in a tariff against foreign importation, as without a producers' agreement regulating price and output, which would be impossible under our present laws, the surplus resulting from domestic production would rapidly bring down the price to a parity with the price abroad." Mr. A. B. Parsons, assistant secretary of the Institute, maintains that, "The only effect of a tariff would be to cause a lot of complicated bookkeeping entailed by the smelting and refining of foreign silver 'in bond.' No one bothered to oppose the tariff on the mere ground that it was a nuisance, and the Senate voted aye because a few members asked it to. The tariff cannot benefit the owner of domestic silver mines, and is consequently a mere gesture." Ample additional testimony is available to indicate that the stand taken by *Engineering and Mining Journal* in opposing this duty was justified as reflecting and anticipating mature opinion throughout the industry.

The vituperation and calumny that characterized Senator Pittman's speech before the Senate on April 18, in an effort to destroy the influence and reputation of this publication, is a more serious matter. Every time a member of the Senate of the United States abuses his Senatorial privilege of free speech and immunity from legal action, and makes a scurrilous and untruthful attack, he still further weakens public confidence in the integrity of that chamber as a legislative body. He encourages—by causing suspicion and distrust of Congress and doubt as to the country's capacity for orderly and just government—those elements who would destroy authority, but who, fortunately, do not possess a Senator's exemptions and prerogatives.

To its readers and to the mining industry of the United States, *Engineering and Mining Journal* need not adduce proof of its obvious independence of opinion. To Senator Pittman and to his colleagues, however, it takes this opportunity to issue a categorical denial of his accusations of hypocrisy and venality in its editorial attitude on the silver tariff, an attitude that was the outcome of an impartial and spontaneous analysis, suggested by no individual or group of individuals outside the editorial staff. The criticism of Senator Pittman's proposal, to which he takes exception, was written without consultation with or consideration of the aims of the Jewelers' Protective Association, or of any other organization. *Engineering and Mining Journal* deplores the malevolence of Senator Pittman's incitation to the Senate: "Read that brief [of the Jewelers' Vigilance Committee] and read this editorial, and you will see that the same person wrote both of them." It finds no inconsistency, as the Senator avers, in the fact that the tariff was opposed as likely to prove a delusion to the producer and a tax on the consumer. None but a short-sighted policy would advocate a benefit to one of these closely interlocking interests that would prove burdensome or harmful to the other.

A review of the editorial attitude taken by *Engineering and Mining Journal* for more than a quarter of a century under its present ownership will indicate that it has never opposed any measure that is practicable, helpful, and just. It gave unqualified support to Senator Pittman in regard to his silver purchase bill, upholding the repurchase, under the Pittman Act, of 208 million ounces of silver. Nor can one argue with hope of success that its editorial policies have been changed. Four years ago Senator Cameron, of Arizona, advocated a tariff on copper. Such a measure was opposed by this publication for the chief reason that—as is true for the pending silver tariff—it was impracticable and of doubtful benefit.

On May 2, the House of Representatives defeated the silver tariff by a vote of 202 to 72. Although not necessarily final, this action probably means that the silver clause will be omitted from the completed tariff bill when it is submitted to President Hoover for approval.

Engineering and Mining Journal prizes above all material and professional compensations a reputation that has been gained during more than six decades of service to the mining industries, a reputation that is the reward in the major part for the verity and independence of its editorial attitude. It makes no claim to infallibility of judgment or superior prescience in analysis, but it takes pride that its findings and recommendations are based on pertinent facts, all of which it seeks and none of which it ignores. A mistake, when one is made, is willingly acknowledged; but the publication will not alter its course because of threats, untruthful attacks, or intimidation. Believing that a need of the times is sane counsel and fearless criticism, *Engineering and Mining Journal* purposes to continue an editorial policy that will follow the precepts laid down by Lincoln: "With malice toward none; with charity for all; with firmness in the right . . ."

A Plea for Uniformity in Measurement Units

SOLOMON, the accredited author of Proverbs, maintained that "divers weights and divers measures" were an abomination. A multiplicity of units still persists, an obstacle to frugal and prompt research, to the efficient dissemination of knowledge, to the interchange of information, to an understanding of fact and an appreciation of achievement.

A series of articles and reports on a distant project was recently submitted to a consulting engineer. From a study of their contents one could infer but not analyze. Essential data were given variously in terms of tons, gallons, grams, pounds, ounces, acres, miles, shillings and pence, with thermometer readings based on a scale designed early in the eighteenth century on the mistaken assumption that minimum cold was reached with a mixture of ice and salt! No self-respecting engineer would spare time to reduce such figures to a common denominator unless he could be reasonably sure that steps were being taken to put an end to such wasted labor and mental chaos in the future.

The English-speaking peoples stand almost alone in their apparent determination not to take advantage of the opportunity to establish logical standards of measurements. Leadership is evidently lacking, although the spirit seems to be willing, in places. Forty nations have

already adopted metric standardization. A system of money units that permits easy calculation is in use in the United States and in Canada, but weights and measures in these countries still conform to what cannot even be described as a system. Science and research the world over have long since discarded the shackles of unrelated units. Industry, among the English-speaking peoples, despite the urgent need for a simplicity that begets economy, still clings to awkward units imposed mostly by ancient traders with insular notions.

No nation can afford to resist so logical a reform as the abolition of unrelated units. In their internal affairs, in their relations with one another, all countries would benefit by the adoption of the metric system. This labor-saving device, this aid to clear thinking, to precise analysis, to accurate comparison, can be made to form the basis of a universal language. It is as essential to the efficient conduct of business as it is in the technical and economic research that must precede a successful business venture.

A Social Center for Mining Engineers in New York

THE urbanites of the United States are perhaps the most club-ridden people on earth, so temerity is needed to suggest that still another club, in New York City of all places, could serve any group of professional men not already provided with an adequate choice of luncheon accommodations. And yet, what place is there in the city where a mining engineer may go for luncheon with reasonable certainty of seeing confrères anxious as he is to swap experiences?

So, *Engineering and Mining Journal* welcomes the new Mining Club, now in process of organization, as announced recently. Its opportunities are obvious. Not only will its monthly luncheons become so interesting that a large attendance may be assured without advertising, its surroundings may prove so congenial that resident and visiting mining engineers will instinctively think of it around one o'clock every day. A great deal of enthusiasm has been shown, and the limit of resident membership has already nearly been reached. Provision has been made for fifty non-resident members, which number, one may predict, will have to be expanded.

Mining engineers visiting London are familiar with the Mining and Metallurgical Club in that city, which for many years has been a most successful institution. One who cannot find a friend or acquaintance there at midday must indeed be a hermit or of only provincial experience. No good reason appears why the Mining Club of New York may not successfully emulate its predecessor in the other great mining center of the world, by capable direction, the active interest of members and good service.

Manganese Producers Must Make Good

IN THESE anxious moments for those who hope to benefit from the passage of the Tariff Bill, the would-be beneficiaries might discipline themselves by giving thought to what they will do if their particular plea be granted. Especially the manganese producers. The latter have prayed, not so much for protection, which they already have, but for continuance of it. Even though the pending bill be vetoed, this protection will remain unless specifically repealed. The producers have hoped that Congress, by reaffirming it, would remove the element of uncertainty. Now they should think seriously of the future.

For eight years the manganese producers have had protection without achieving much production. A good excuse they can give for this, but it is one that will not last forever. They should strive to increase production With the old rate of duty ratified, and its scope widened to include ores of lower grade, consumers would probably be inclined to accept the domestic product, provided it met their specifications as to grade and tonnage.

The purpose of the protective tariff has never been to make possible the bringing of properties to an indeterminate stage of development solely to make them salable. With further efforts, the producers can undoubtedly make a better showing than they have made to date, provided the few consumers will give them half a chance. They must increase production, or, one may safely predict, they will ultimately lose the protection now enjoyed. One and all, actual producers and would-be producers, they should realize that, whether or not the tariff bill be signed, they must make good.

Ore Hoisting in the Butte District

Part I

C. M. Harrer and L. S. Farnham

Mining Engineer, Butte, Montana

Structural Engineer, Anaconda Copper Mining Company

IN MANY mining districts future developments are uncertain. A mine or district may show either long life or prove to be a fizzle. Exceptional confidence, however, is evident in the future of the Butte district; this attitude is substantially shown in the fact that one conservative corporation has installed complete new hoisting plants designed for a depth of 5,100 ft., which is the generally accepted maximum depth of single-stage hoisting for economical operation. This trend toward deeper mining is significant, as the deepest shaft in the district at present is 4,000 ft.

New structures designed for future deep-hoisting conditions must provide for new requirements and possible changes in transportation, hoisting, and preparation of run-of-mine ore. For example, preparatory treatment plants with a gravity feed or conveyor belt system to the skip bins of the headframe may be installed in the near future. These may not only prove necessary but highly profitable. Forecasting developments in mining is at best an uncertain and difficult task that requires an intimate knowledge of existing and past conditions. Its importance in the design of steel headframes cannot be stressed too much, and can be fully realized only by men who have followed mining and witnessed the rapid growth and radical changes in some of the important mining districts. The general dimensions of a headframe can usually be determined if the method of hoisting is known; but if hoisting conditions are to be changed within the life of the structure, future developments and changes must be considered.

Three generally accepted methods of handling ore and waste through shafts are employed in the Butte district; namely, cars to cages; cars to skips; skip pockets to skips. With the exception of a few properties where buckets are employed, the cars to cages method is used almost exclusively in the smaller mines. The Anselmo, Lexington, Goldsmith, and the Orphan Girl are so equipped. Where caging is used exclusively, trips of two, three, and four decks or cages are employed, depending on the vertical clearance of the headframe. This practice is a factor influencing the height of headframes. Automatic skip dump hoisting has superseded cage hoisting at the larger properties.

Many of the mines, however, resort to the cage method to transport waste to the surface when stope filling is temporarily suspended. In the method of stope filling commonly used, waste transfer chutes open into the stopes to be filled, and a regular system of waste transfer from level to level is employed, except where enough barren development is under way to furnish the waste required for the stopes in the block below. As the amount of waste available varies and seldom is equal to the amount required in any one block, filling which is obtained from barren raises, drifts, crosscuts, shaft sinking, and underground sorting is transported from level to level within the mine to wherever it is needed. An auxiliary to the main hoists, known as the "chippy" lift or hoist and equipped with cages to handle waste, men, and supplies, provides interlevel service for these operations. Where the amount of barren rock exceeds filling requirements, the surplus is transported to the surface either in cars run onto the cages or in skips to the skip bins. Underground, waste rock is generally dumped directly into the skips from the cars. Before any waste is dumped into the skip bins, they are emptied of ore, as the waste goes directly to the dump.

In some of the mines vein mineralization may be erratic or low-grade. The expense of cutting large stations and skip pockets under such circumstances is inadvisable. In other instances, the

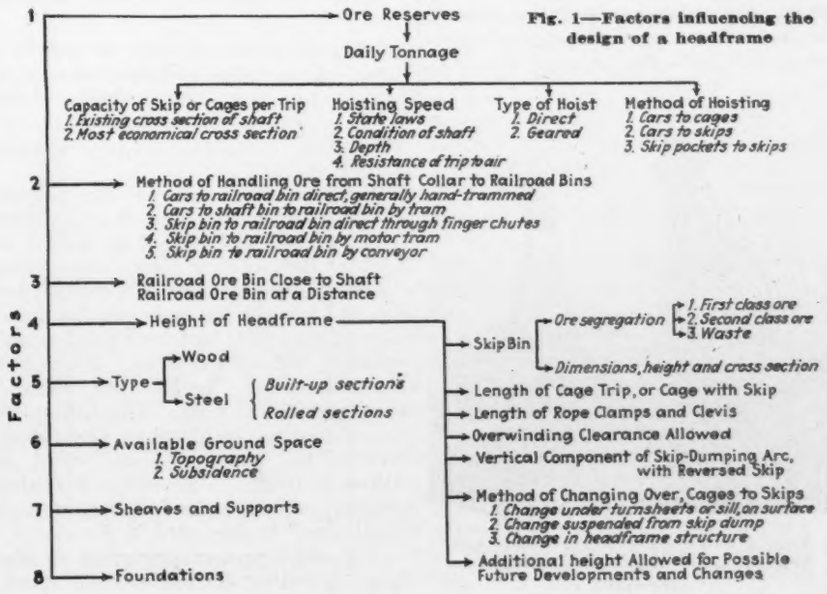

Factors
1
Ore Reserves
Daily Tonnage
Capacity of Skip or Cages per Trip
1. Existing cross section of shaft
2. Most economical cross section
Hoisting Speed
1. State laws
2. Condition of shaft
3. Depth
4. Resistance of trip to air
Type of Hoist
1. Direct
2. Geared
Method of Hoisting
1. Cars to cages
2. Cars to skips
3. Skip pockets to skips
2
Method of Handling Ore from Shaft Collar to Railroad Bins
1. Cars to railroad bin direct, generally hand-trammed
2. Cars to shaft bin to railroad bin by tram
3. Skip bin to railroad bin direct through finger chutes
4. Skip bin to railroad bin by motor tram
5. Skip bin to railroad bin by conveyor
3
Railroad Ore Bin Close to Shaft
Railroad Ore Bin at a Distance
4
Height of Headframe
Skip Bin
Ore segregation
1. First class ore
2. Second class ore
3. Waste
Dimensions, height and cross section
5
Type
Wood
Steel
Built-up sections
Rolled sections
Length of Cage Trip, or Cage with Skip
Length of Rope Clamps and Clevis
Overwinding Clearance Allowed
Vertical Component of Skip-Dumping Arc, with Reversed Skip
6
Available Ground Space
1. Topography
2. Subsidence
Method of Changing Over, Cages to Skips
1. Change under turnsheets or sill, on surface
2. Change suspended from skip dump
3. Change in headframe structure
7
Sheaves and Supports
8
Foundations
Additional height Allowed for Possible Future Developments and Changes

Fig. 1—Factors influencing the design of a headframe

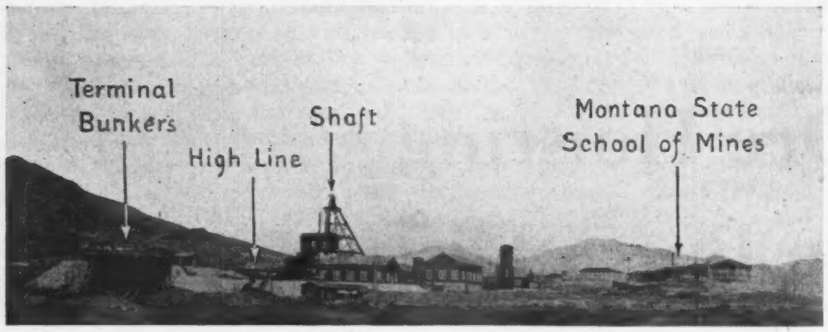


Fig. 2—The Orphan Girl mine

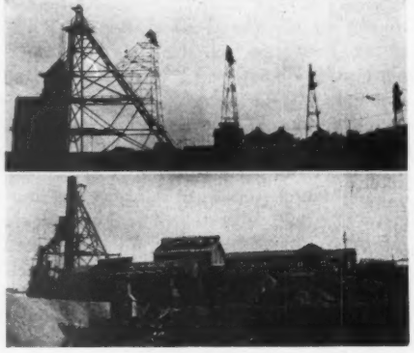
ground may be heavy and difficult to support over large excavations. The method of hoisting ore under such conditions will therefore be the cars-to-skips method. The contents of the loaded cars on the various levels are dumped directly into the skips, which are spotted about 6 in. above the level of the turnsheets. This does not necessarily imply that the whole mine is thus served. Only certain levels are operated in this manner, others being equipped with skip pockets. Where ore reserves can be fairly closely estimated, and where they indicate the advisability of a skip pocket, the ground permitting, large stations with skip pockets under the station sills are driven off the shaft when opening new levels.

Hoisting details are therefore dependent upon underground conditions and operations, such as the extent and continuity of the orebody, the method of opening up levels, the mining method, and the transportation of ore to the shaft stations. The grades and size of orebodies are considered in relation to market conditions in determining the daily tonnage rating of the mine and the planning of operations.

Methods of transporting the ore from the collar of the shaft to the loading bins are listed in the chart, shown in Fig. 1. Hand tramming car directly to terminal bins presupposes a sharp relief in topography, such that the top of the loading bin will be approximately on a level with the collar of the shaft.

Figs. 3 and 4—The Never Sweat and Original headframes. The latter is to the right.

This method is used at only a few small mines, leases, and prospects, but was extensively employed in the early days when low headframes were in vogue and tonnages were comparatively small. A variation of the method that is used at several properties consists of a headframe of medium height and a "high-line" or trestle that connects the headframe with the loading bins or railroad cars. At the Anselmo mine no terminal bunkers are used, the contents of the loaded cars being dumped directly into railroad cars from a tipple arrangement on the "high-line." All of the early wooden headframes, with the exception



Figs. 5 and 6—The Granite Mountain headframe is seen above. Below is the surface plant at the Speculator shaft.

of the old timber structure at the Belmont mine, were built to conform to surface hand-tramming methods. Many were subsequently partly or entirely reconstructed to adapt them to automatic skip dumping.

Where the distance from the hoisting plant to the loading bins is excessively long, an intermediate bin or hopper is built at the hoisting plant. Ascending (loaded) trips of cars (in cages) are emptied into the bin or hopper by hand. Special trammers load from this bin and tram to the loading bin. At present electric motor lorries are usually employed in this work. This method is exemplified at the Orphan Girl mine, west of the Montana State School of Mines, at Butte. A general view of this property, showing terminal bunkers and "high-line," is presented in Fig. 2.

The older proven properties of the large operating companies have standardized their equipment to provide ore discharge from the skip bin to the loading bin through chutes or by a motor tram from skip bin to railroad loading bin, the general topography determining the choice of either arrangement. The increase of daily tonnages to their present proportions necessitated the installation of automatic skip-dump hoisting arrangements, which have been developed almost to the exclusion of other methods. Transfer from skip bin to railroad bin by chutes is exemplified at the Never Sweat, Original, Speculator, and Granite Mountain properties, which are shown in Figs. 3, 4, 5, and 6. Only two distributing chutes are used in the Speculator and Original installations, which are so nearly alike that a description of one will suffice for both.

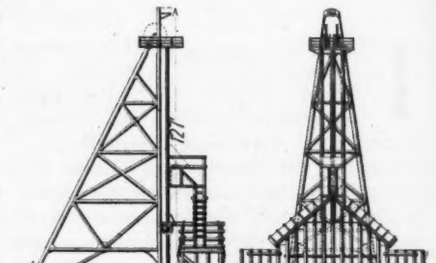


Fig. 7—General design of the Original headframe

General details of the headframe structure at the Original property are shown in Fig. 7. The steel headframe, which was erected in 1902, is of the built-up section type and designed for automatic skip dumping. From the skip, the ore passes down the "throat" through two chutes or fingers, and thence into two loading bins, each having a storage capacity of 100 tons. Chutes are lined with heavy plates. The headframe is 127 ft. high from the collar to the sheave center, and is a distinct variation from the sill type of structure. The present depth of the mine is 4,000 ft., the deepest in the camp. Weight of a cage is 3,900 lb.—four cages to the trip. The skip is suspended

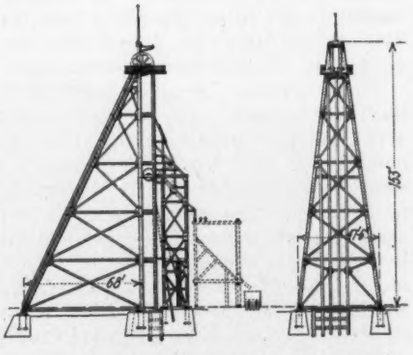
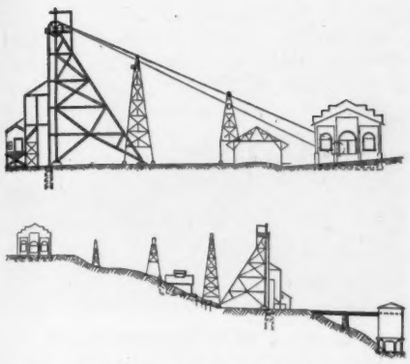


Fig. 8—Headframe at the Leonard No. 1 shaft



Figs. 9 and 10—Sketch of the new Belmont installation is seen above. Below is a profile of the new Mountain Consolidated surface plant.

under a bonneted cage. The weight of the skip empty is 7,800 lb. Ten-foot sheaves are used over the main hoisting compartments, with 1½-in. ropes. Skips are hoisted in balance. The Speculator headframe is situated uphill above the loading bins, which difference of elevation permits a correspondingly smaller structure, 50 ft. in height. Seven-foot sheaves are used, with flat cable. Only one loading bin is available, and the chutes empty into either end of it. Deflectors are sometimes introduced to spread the ore uniformly.

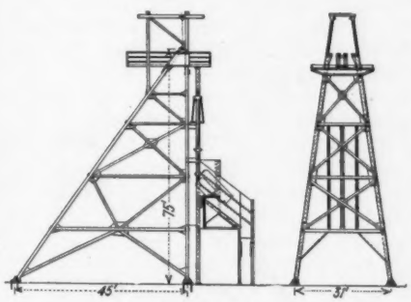


Fig. 11—Details of the Elm Orlu surface plant

The headframe at the Leonard No. 1 shaft, at Meaderville, is of special interest in that the collar of the shaft and the sill of the loading bin are on the same level. This necessitated an unusually high structure to provide gravity flow from the skip dump through chutes and by distributing lorry to the loading bin. Fig. 8 shows the design of this structure, which is the highest erected in the district, being 141 ft. from shaft collar to center of sheaves and 152 ft. over all. The frame was built by the American Bridge Company in the heyday of the Boston & Montana Company in 1905. The mine is served through a four-compartment shaft, two compartments of which are used for balanced skip hoisting, one compartment of which is used for chippy cages, and the fourth for heavy pump-column pipes, power cables, and compressed-air lines.

Operations at the mine have reached a depth of 2,800 ft. Ore is hoisted in 5-ton skips of the Kimberly type, suspended beneath a cage. The weight of the skips is about 8,500 lb.; ore load varies between 10,000 and 10,700 lb. Four-deck cages are used for hoisting men, eight men being hoisted on each deck. A 1½-in. round hoisting rope is used in the skip compartments. Present rate of hoisting is about 3,000 ft. per minute. Twelve-foot sheaves set 5 ft. 10 in. on centers are used over the main hoisting compartments. The chippy sheave, which is 6 ft. 9 in. in diameter, is set 75 ft. above the collar of the shaft on tie girders to the skip bin. The two skip bins have a capacity of 75 tons each. From the skip bins, the ore passes through chutes to the railroad loading bin, which has a capacity of 1,500 tons and is fireproofed on the exterior with gunite. The headframe is made of built-up sections. Many engineers, however, now prefer the use of rolled members in headframe construction.

The front posts are built up of two 12-in. channels, with 16-in. cover plates, $\frac{5}{16}$ and $\frac{1}{4}$ in. thick, laced on the inner side. Construction of the two lower panels in the plane of the back legs consists of 12-in. channels, with a 16-in. cover plate $\frac{3}{8}$ in. thick. The third section is made up of two 12-in. channels, with a 16x$\frac{5}{16}$-in. cover plate; the upper two sections are of 12-in. channels, laced on both sides. Main struts and diagonal braces are constructed of two channels with top and bottom battens, and guide columns are made of two 12-in. channels. Skip bins are supported on columns constructed of two 10-in. channels, laced on both sides. Total shipping weight of the headframe was 346,425 lb. All sway brace members in the first bent plane converge toward the center of the structure. This practice has been discontinued so that the lowering or hoisting of sheaves within the headframe may be facilitated. Formerly, sheaves were hoisted outside the structure. Another feature that has also been discarded is the "tied-in sill." The Leonard No. 1 headframe was designed for a depth of 3,500 ft., but at 2,800 ft., the present depth, it vibrates during hoisting operations.

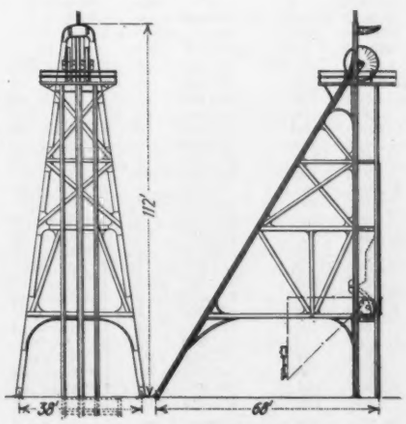


Fig. 12—Headframe structure at the High Ore shaft

An elevation drawing of the new Belmont installation is shown in Fig. 9, and the profile of the new Mountain Consolidated surface plant in Fig. 10. Both installations exemplify design based on motor transportation between skip pockets and loading bins. The Belmont has the longest lorry haul in the district. At the Mountain Consolidated a cylindrical steel loading bin has been installed. The general design of the Elm Orlu headframe, which was erected

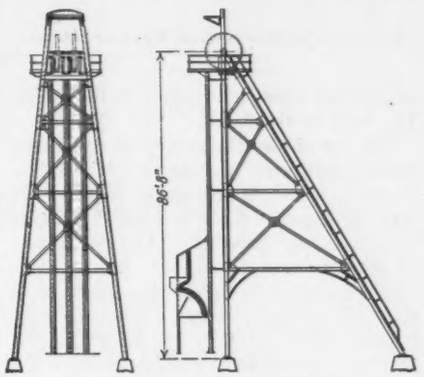


Fig. 13—General design of the Black Rock No. 1 headframe

in 1912, is shown in Fig. 11. In 1915, when the headframe was moved to a new position, two additional back legs were added to bring the resultant well within the 75-ft. structure. In Fig. 12 is shown the design of the headframes at the High Ore, Diamond, Never Sweat, and Tramway mines, all of which are identical. The structures are of heavy construction, and 100 ft. high from shaft collar to sheave center. They are of the built-up section type. In the Diamond and Tramway structures, skip dump and bins are in front of the forelegs, whereas at the Never Sweat and High Ore mines they are built within the head structure and the skips dump inward instead of outward. At the High Ore mine the ore is transported from the skip bins to the loading bin by motor lorry, and at the Never Sweat three-finger chutes extend from a common throat to the first ore bin; the other bins are filled by motor lorry.

The two steel structures of the Butte & Superior company were adapted to a variation from any other pre-existing method of transportation between collar of shaft and loading bins. The skip bins discharge into cylindrical steel bins, which in turn discharge onto a conveyor belt that passes through a picking plant and discharges into loading bins. In 1912, the first steel headframe, shown in Fig. 13, was erected at the Black Rock No. 1 shaft. It was designed for a skip dumping outward, leaving the space within the structure open, and is of the built-up section type, 86 ft. 8 in. from shaft collar to sheave center. Sheaves 9 ft. 10 in. in diameter are used over the main hoisting compartments. The skip dump is an adaption

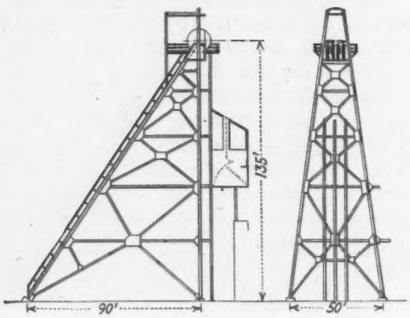


Fig. 14—The Black Rock No. 3 headframe

of the old Kimberly type. A flat hoisting rope is employed.

Fig. 14 shows the design of the Black Rock headframe erected in 1915 at No. 3 shaft. The structure is built of *H* sections, and is 135 ft. high. Sheaves are 12 ft. in diameter. The simplicity of its details is apparent.

A general drawing of the structure at the No. 4 shaft of the Pittsmont mine is shown in Fig. 15. The headframe is of the *A* type and unusually massive for its height of 50 ft. The foundation for the structure was built up with the slag from the Pittsmont smelter. Headroom beyond a low limit was not needed, as the method of hoisting employed at that time was "cars to cages." With the introduction later of automatic skip-dumping arrangements, additional headroom became necessary. Several mines avoided erecting new structures by constructing a 40-ft. level (see Fig. 17) or adit to the shaft and by putting in steel "sunken" skip bins around the shaft. Electric motor lorries, operating over a short trestle, tram the ore from the skip bins on the 40-ft. level to the loading bins.

During 1927, three of the important mines, the Mountain Consolidated, Belmont, and Badger State, were equipped with new surface plants designed for hoisting from a depth of 5,100 ft., the accepted maximum depth of single-stage hoisting. General details of these headframes are shown in Fig. 16. They are 125 ft. high from shaft collar to sheave center, and are designed for automatic skip dumping in two compartments. Their construction is of the rolled-section type, and convenience of erection was an important factor in their design. Sheaves over the main hoisting compartments are 12 ft. in diameter, and over the chippy compartment, 10 ft. in diameter. All sheaves are placed at the top of the frame. At the Badger State and Belmont, three hoisting compartments are employed, two for balanced skip hoisting, and one compartment for the chippy cage. A

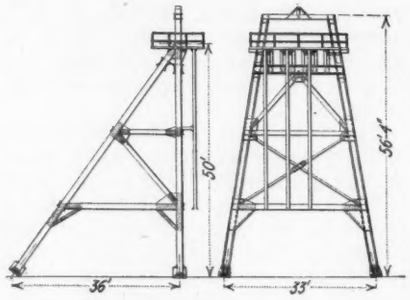


Fig. 15—Headframe at No. 4 shaft of the Pittsmont mine

fourth compartment is used for pipes and cables. At the Mountain Consolidated, five compartments are to be used: two for balanced skip hoisting, one compartment for the chippy, one for pipes and cables, and one for ventilation. Ore at these three installations is hoisted by $1\frac{7}{8}$-in. steel ropes in automatic self-dumping skips of 7-ton capacity. The skips are suspended beneath a bonneted single-deck cage. Four-deck cages are used for man trips. Main posts or front columns are 14-in. *H* columns; and guide columns are 10-in. *H* sections. The back legs are also 14-in. *H* sections. Main struts and diagonals are rolled *H* sections.

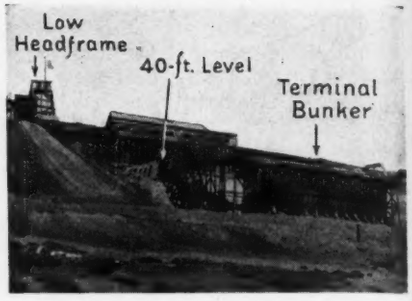


Fig. 17—A 40-ft. level installation

At the Mountain Consolidated mine (see Fig. 10), the hoist house was first placed closer to the collar of the shaft than it now is. Subsequent examination showed the first site to be unstable as a result of stoping operations. The new building was therefore erected on the brow of the hill, as shown in the figure, The position of the old hoist building is indicated by the dotted outline. In the foreground is the old engine room. Idler towers, provided with sliding idlers and a vertical adjustment, are installed in all three headframes to carry the ropes.

The year 1897 marked the first use of steel in the design of headframes in the Butte district, when the first steel structures were erected at the West Colusa shaft and the St. Lawrence mine. Since then many other steel headframes have been erected, and they are now common in the district.

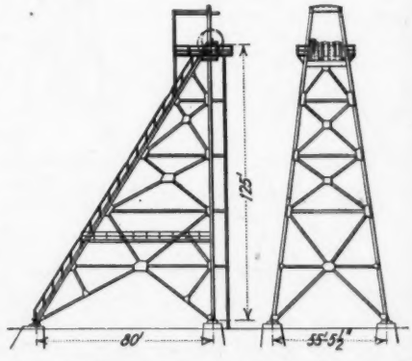


Fig. 16—General design of headframes at the Mountain Consolidated, Belmont, and Badger State shafts

The chart shown in Fig. 1 indicates most of the points considered by the designer or mine manager in planning the type of structure that will most efficiently meet operating conditions. At present nearly all of the large producing mines are equipped with steel headframes. Underground conditions that influence the design of head structures can be approximated from an article by C. M. Harrer that appeared in the July 30, 1927, issue of *Engineering and Mining Journal*.

At those properties where motor trams or lorries are used, the skip bin serves as a storage hopper. Capacity of the hopper is determined by the

Statistics Pertaining to Headframes in the Butte District

Shaft	Weight in Pounds, Cage	Weight in Pounds, Skip	Ore Capacity of Skip, Tons	Depth of Shaft, Feet	Ore Hoisting Speed, Feet per Minute	Height of Headframe, Feet	Weight of Headframe, Pounds	Diameter of Sheaves, Feet	Size and Type of Hoisting Rope
Anaconda	4,000	8,500	5	2,800	2,200	58.82	74,700	10	7/8" x 1/2", flat
Badger State	4,000	10,500	7	3,500(a)	2,800	129.5	256,000	12	1 1/8" diam., rd.
Belmont	4,000	10,500	7	3,400(a)	2,600	129.5	256,000	12	1 1/8" diam., rd.
Belmont (old)	3,800	8,900	5	3,400	2,250	114	Timber	10	7/8" x 1/2", flat
Berkely	3,900	8,500	5	3,200	2,600	80	Timber	10	1 1/8" diam., rd.
Black Rock No. 1	3,800	10,000	10	2,800	2,600	152	250,000	10	1 1/8" diam., rd.
Black Rock No. 3	3,800	10,000	10	2,800	2,600	152	250,000	10	1 1/8" diam., rd.
Diamond	3,850	8,960	5	3,400	2,800	100	318,000	10	6" x 1", flat
Elm Orlu	4,000	10,000	7	3,300	2,600	94	65,000	10	6" x 1", flat
High Ore	3,850	8,960	5	3,400	2,600	100	292,000	10	6" x 1", flat
Leonard	3,800	8,500	5	2,800	3,000	141	346,425	12	1 1/8" diam., rd
Mountain Con	4,000	10,500	7	3,600(a)	2,800	129.5	256,000	12	1 1/8" diam., rd.
Mountain Con. (old)	3,850	8,900	5	3,500	1,000	100	Timber	10	1 1/8" diam., rd.
Mountain View	4,000	11,000	5	2,600	2,200	80	183,000	7 1/4	7" x 1", flat
Never Sweat	3,200	5,700	3 1/2	2,800	2,600	100	315,000	10	1 1/8" diam., rd.
Original	3,900	7,800	4	3,800	2,600	112	318,000	10	1 1/8" diam., rd.
Orphan Girl	3,050	No skips	..	1,000	1,500	70	79,000	7	1" diam., rd.
Pennsylvania	3,500	8,500	5	3,400	2,800	100	315,000	12	1 1/4" diam., rd.
Pittsmont	1,250	3,875	5	1,600	2,600	58.5	41,500	8	6" x 1", flat
St. Lawrence	3,900	7,000	7	2,100	1,000	97	117,000	10	7" x 1", flat
Speculator	2,100	11,000	5	2,800	2,200	50	42,200	10	1 1/8" diam., rd.
Stewart	3,800	8,500	5	3,800	2,800	100	292,000	10	1 1/8" diam., rd.
Tramway	3,850	8,500	5	2,800	2,800	100	315,000	12	1 1/8" diam., rd
West Colusa	3,500 / 2,200	No skips	..	2,200	2,800	50	43,000	10	4" x 1", flat

(a) Hoisting installation designed for depth of 5,100 ft.

skip capacity, the number of skip trips made in a unit of time, and the number of trips made by the motor lorry in the same unit of time. The length of the haul to the loading bins is a factor in determining the capacity of the lorry required. Nearly all lorries are the bottom-dumping type.

In the calculation of stresses, the assumption of a daily production, and the observance of state laws, the condition of the shaft and the maximum depth of hoisting are influencing factors. At present, Montana laws are liberal, the important provision that has to be definitely taken into account being the speed of hoisting and lowering of man trips, which operations are limited to a maximum speed of 800 ft. per minute.

Replacement of headframes indicates that mines are generally in a more or less advanced stage of development. The maximum rock hoisting speed may therefore be determined by shaft conditions and cross-section. No shaft of any great depth can be held in perfect alignment within reasonable cost limits. As a consequence, speed is sacrificed somewhat to prevent bad wrecks, or what is locally known as "running a trip into the woods." As working depths increase, speed will be decreased, owing to the additional length of hoist, increased weight of cable, and diminished starting acceleration. The type of hoist chosen, whether geared or first motion, will also influence the daily tonnage. Most hoists in Butte are direct-connected, first motion machines.

Power Requirements in Metal Mines

MODERN mining utilizes electrical power in so many basic operations that the power ratio, or kilowatt-hours per ton of product—like the labor ratio, tons per shift per worker—possesses considerable interest as an efficiency factor. In common with the labor ratio, its quantitative statement does not admit of satisfactory comparison unless conditions affecting mine operation are also known. Recently, in several U. S. Bureau of Mines circulars*, mining costs and quantities involved are given in sufficient detail to afford information on this power factor. With one exception, the figures given in this article are taken from the circulars.

The lowest power ratio given is that of Alaska Juneau—1.61 kw.-hr. per ton. F. W. Maclennan, in a recent paper on the Miami Copper's methods, states that the power requirement for mining at that mine is about 1.9 kw.-hr. per ton, of which amount slightly more than 1 kw.-hr. is required for hoisting. Both mines are operated by caving methods, which, however, differ considerably. Alaska Juneau is an adit mine where hoisting is incidental. The Miami mine is a shaft mine, and hoisting there, as Maclennan states, requires more than half the power. Alaska Juneau produces about 10,000 tons per day and Miami about 17,000 tons per day, the former using 0.4 lb. explosives per ton and the latter 0.2225 lb. per ton. Comparison of the 1.61 kw.-hr. of the former and the 0.9 kw.-hr. (total less hoisting) of the latter is more nearly parallel. The difference is easily accounted for by the greater hardness of the Alaska Juneau orebody, which necessitates a large amount of blockholing. A completely mechanized coal mine in eastern Ohio reports a power ratio of 3.59 kw.-hr. per ton. Four other eastern Ohio coal mines on the same vein report an average of 4.76 kw.-hr. per ton. These coal mines are operated by drifts from the surface or by shallow shafts. Comparison between large metal mines systematically operated and coal mines of a similar order brings out the significance of caving as a contributing factor to low power requirements. Another basis of comparison is afforded by Utah Copper, an open pit. Total power for stripping and mining is given as 1.84 kw.-hr. per ton.

The highest power ratio is that given by the Old Dominion mine, at Globe, Ariz., operated through shafts to a depth of 2,200 ft. It is a very wet mine, a daily average of 3,659,000 gal. being pumped during 1928. Its output is somewhat less than 1,000 tons per day. Power requirements per ton in kilowatt-hours is as follows: air compression, 17; hoisting, 9.77; pumping, 25.51; ventilation, 6.6; lighting and haulage, 2.7; total, 61.5 kw.-hr. per ton. At the Morning mine, Mullan, Idaho, power requirement totaled 39.4 kw.-hr. per ton, divided as follows: air compression, 28.82; hoisting, 4.35; pumping, 2.26; ventilation, 2.74; lighting, 1.2. At the Hecla mine, Burke, Idaho, total power was 16.9 kw.-hr. per ton, divided as follows: compressors, 10.9; hoisting, 4.3; ventilation, 0.84; lighting, 0.85. Pumping power seems to have been either omitted or included in other quantities. Both the Morning and Hecla mines are shaft mines in which overhand stoping is practiced. Daily outputs are from 500 to 1,000 tons. Hoisting is from 2,000 to about 3,000 ft. in depth.

Miscellaneous examples are given in the accompanying table. The second and third are copper mines, shaft operated and in hard rock and hard ore. The first, also shaft operated, is in rock and ore of intermediate hardness. The next three are zinc mines, two of which are in the Tri-State district and the third of which is in Tennessee. The two Tri-State mines range from 350 to 380 tons per day from 200 to 300 ft. in depth and the Mascot mine No. 2 mines about 2,200 tons per day from about 600 ft. in depth. Rocks are of intermediate hardness. One example of hard hematite-ore mining and two examples of soft hematite-ore mining follow. Depth of mining is of the order of 500 to over 1,000 ft. and output is from 500 to 1,000 tons per day. All three are shaft-operated mines.

Analysis of Distribution

	Kilowatt-Hours per Ton						
	Air Compression	Hoisting	Pumping	Ventilation	Haulage	General Underground	Total
Minas de Matahambre	8	3	1.79	1.22	....	....	14.01
Cananea (Colorado mine)	6.045	3.373	0.454	0.195	0.986	0.238	11.29
Tennessee Copper Company	....	....	....	....	....	....	7.92
Mascot, Tenn.	3.81	1.06	4.04	0.05	0.63 (a)	0.09 (b)	9.68
No. 1 Mine, Picher, Okla.	6.00	2.77	0.22	....	0.92 (a)	....	9.91
No. 2 Mine, Picher, Okla.	2.51	2.42	0.82	....	....	....	5.75
Marquette Range, Michigan (hard hematite)	4.33	2.04	4.02	....	0.76 (a)	0.41 (b)	11.56
No. 1 Mine, Menominee Range, (soft hematite)	5.90	3.64	1.89	....	....	0.47 (c)	11.80
No. 2 Mine, Marquette Range (soft hematite)	4.24	2.30	1.78	....	0.94 (a)	0.13	9.39

(a) Includes lighting; (b) Mechanical loading; (c) Lighting.

*Summarized from Bureau of Mines Information Circulars 6186, 6247, 6145, 6193, 6234, 6138, 6179, 6180, 6237, 6238, 6232, 6149, 6208, and 6200.

The Island Falls power plant, in Saskatchewan

"Manitoba Metal"

THE progress of the Flin Flon enterprise indicates that this phrase will soon take on added significance. R. H. Channing, Jr., describes the plan for large-scale operations at this new Canadian copper-zinc mine in an official statement.

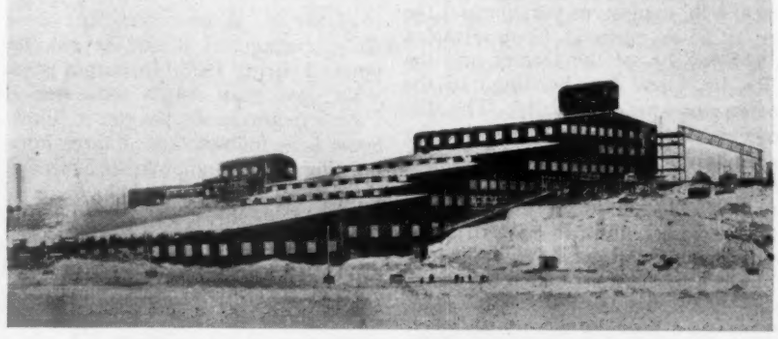
BY JULY of this year, power from the hydro-electric power plant at Island Falls will be turned on at the Flin Flon property of Hudson Bay Mining & Smelting, in northern Manitoba, and by the end of the year, production of copper-zinc ore on the scale of 3,000 tons daily will have been started, according to R. H. Channing, Jr., who is in charge of operations for the company. Other interesting details concerning this mine, in which 18,000,000 tons of ore has been proved and to reach which an 85-mile railroad has been built, are contained in Mr. Channing's report in the company's annual financial statement. An abstract of these remarks follows:

In preparation for mining, a five-compartment, steel-timbered working shaft has been sunk to 850 ft. and levels have been established at 390 and 650 ft. The shaft has been equipped with a double-drum Nordberg electric hoist, operating 10-ton skips in balance. Hoisting equipment has a capacity of 3,000 tons per eight-hour shift. Ore will be hoisted and dumped into 2,500-ton steel bins, which are an integral part of the steel headframe. This shaft is also served by a second, smaller Nordberg hoist for handling man and supply cages.

All ore mined underground will be hoisted through this shaft. Later it will also be used for the deeper open-pit ore, which will come to it by means of the 390 level. Drifts on this level have been driven the entire length of the present developed orebody, with crosscuts at regular intervals. On the 650 level, a station has been cut, and crosscutting to the orebody is now in progress. This will be the main haulage level of the mine and will supply 1,000 tons of ore daily at the start. This ore will be mined by the sublevel open-stope method and will be loaded into 10-ton steel cars. Electric trammers will be used. Near the main shaft is a drill-sharpening plant, with equipment to sharpen and temper 4,000 pieces of steel daily. A change house for 350 underground workers has also been built.

The ore deposit to be mined by open pit is 1,500 ft. long at the surface, and has a maximum width of 300 ft. The pit will be worked to a depth of 300 ft. eventually. Most of the waste that will have to be removed will come from a barren central rib and the overhanging east wall, as there is little overburden and the approach cuts will not be heavy. Both the approach and the pit itself are partly beneath the south end of Flin Flon Lake. Dams to shut this area off from the rest of the lake have been built, thus facilitating drainage, with secondary dams as an added precaution.

For open-pit work two 170-ton Marion electric shovels, with 3-cu.yd. dippers, two 85-ton Utah Copper-type electric locomotives, and 22 all-steel automatic air-dump cars, with a capacity of 50 tons of ore each, have been purchased. About 2,000 tons of open-pit ore will be hauled to the main gyratory crusher daily. Underground ore will also be discharged into this crusher, which is in front of the main shaft. It will take ore up to 42-in. size and will deliver a 6-in. product. Further coarse crushing will be done in two 7-ft. Symons cone crushers, followed by two sets of 6x2-ft. Traylor



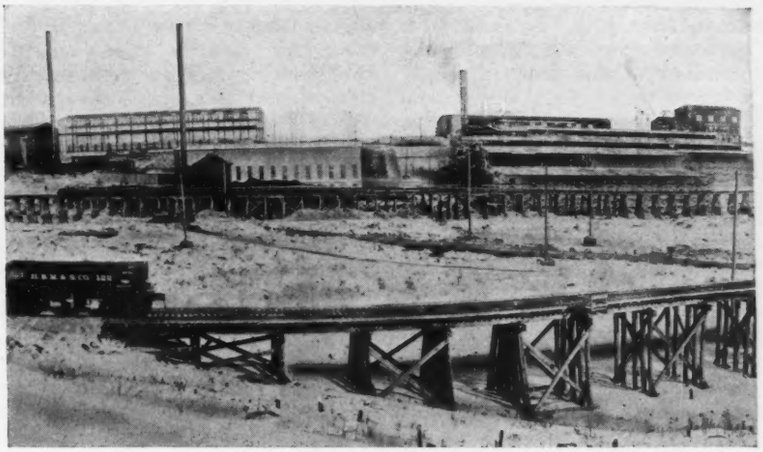
Flin Flon's 3,000-ton concentrator, as it appeared in March

Ajo-type rolls. Crushing capacity is 3,000 tons per eight-hour shift.

The final product from the coarse-crushing plant will be conveyed to seven steel bins, each with a capacity of 1,150 tons, at the head of the mill building. From these bins ore will be fed to six 10-x66-ft. Hardinge ball mills, operating in closed circuit with Dorr classifiers. Two additional mills have been installed for replacement or re-grinding. Ore will be ground to 90 per cent minus 200 mesh and will then be treated in the flotation department, which consists of 466 24-in. Minerals Separation flotation cells and 37 conditioner cells. Sulphide ore and disseminated ore will be treated separately. After floating off most of the talc contained in the ore, the remainder will be sent to the copper-conditioning, copper-roughing, and copper-re-treatment cells. Copper concentrate, after thickening in Dorr equipment, will be sent to the filter plant. Tailing from the copper-re-treatment cells will then be put through the zinc section of the flotation plant and the zinc concentrate thickened and filtered.

Tailing from the disseminated ore will be sent to waste after zinc concentrate production, but the reject from the sulphide ore will be put through the cyanide plant for recovery of gold and silver. It will consist of a 90-ft. Dorr thickener, five Devereux agitators, filters, melting furnace, and a Mills-Crowe cyanide - regeneration plant. Because of the low grade of the material handled and the large initial consumption of cyanide, cyanide regeneration will be necessary for profitable treatment. The gold and silver will be shipped to market as Doré metal.

Zinc concentrate will first be roasted in six seven-hearth, 25-ft. Wedge roasters. The calcine will be put through the zinc leaching plant, from which zinc-bearing solution will be sent to the electrolytic department, in which are 450 electrolytic cells, each holding twenty aluminum-sheet cathodes on which the zinc is deposited. About 13,000 kw. will be used. Zinc-coated sheets will be withdrawn periodically, the zinc stripped off, and sent to an adjoining plant to be cast into zinc slabs for shipment. That part of the roasted zinc concentrate not soluble in dilute acid will be either treated direct or electrically smelted.



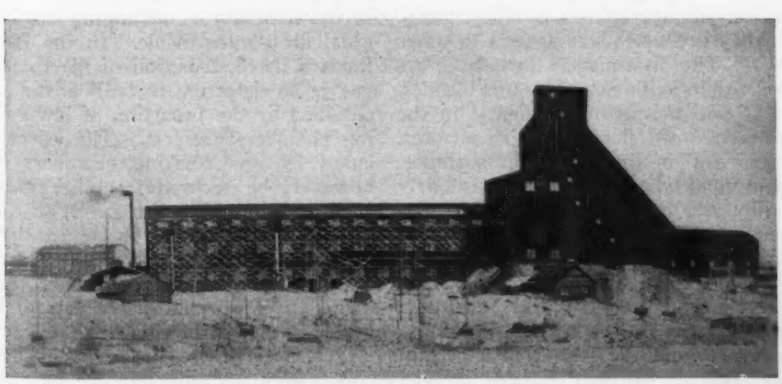
At the left, the electrolytic zinc plant, and at the right, the bedding bins for the copper smelter, with the auxiliary power plant in between

After filtering, copper concentrate will be dumped into four 1,200-ton bedding bins, served by two overhead electric traveling cranes, from which are operated clamshell buckets both for reclaiming material and for mixing the charges. Concentrate will be roasted in three 250-ton, ten-hearth Herreshoff roasting furnaces, and will then be hauled in steel bottom-dump cars to the 100x22-ft. reverberatory furnace. This will smelt from 600 to 800 tons of charge daily and will be connected with two 750-hp. waste-heat boilers. Space for an additional reverberatory has been excavated. A coal-pulverizing plant with a capacity of 100 tons per eight-hour shift will supply coal for the furnace. The converter plant, consisting of two 13x30-ft. Peirce-Smith converters, served by two 30-ton electric cranes, will be in the reverberatory building. Blister copper will be cast into pigs or anodes for shipment to the Canadian Copper Refiners' plant at Montreal. The copper smelter has been designed to treat the company's concentrate output, about 225 tons of Sherritt-Gordon concentrate daily, and some additional custom ore and concentrate. The Sherritt-Gordon contract runs for ten years or until 720,000 tons of concentrate has been treated. A Cottrell plant for treating fume and dust from the zinc and copper roasting plants, as well as from the copper converters, will also be built during the coming summer.

The Island Falls power development will have an installed capacity of 44,500 hp., with provision for further extension to 86,500 hp. In addition, the company is constructing an auxiliary steam-driven electric power plant at the mine to keep essential equipment in operation in case hydro-electric power cannot be delivered. The auxiliary plant consists of three turbo-generators with a combined capacity of 2,300 kw.

Churchill River Power Company is the name of the subsidiary that will operate the Island Falls plant. It is owned entirely by Hudson Bay. A contract has already been made to supply Sherritt Gordon Mines with 5,000 hp. for five years. Sherritt Gordon will build its own transmission line to connect with the main 58-mile line between Island Falls and Flin Flon. At the power plant, the main dam is a gravity-type concrete structure, with a maximum height of 100 ft. and a length of 800 ft. The power house will contain three 14,000-hp. turbines and two 1,250-hp. auxiliaries. Headworks have been built for three additional 14,000-hp. units. The main turbines will operate at 164 r.p.m. with a 60-ft. head. They will be direct-connected to three 12,000-kva., 3-phase, 60-cycle generators. Power will be generated at 6,600 volts and stepped up to 110,000 volts for transmission to Flin Flon.

Water for plant purposes at Flin Flon will be pumped from Embury Lake, 6 miles from the property. This source, which insures an ample supply of pure water, will also be used for domestic purposes. Electrically driven pumps have been installed and a 20-in. wood-stave pipe line will convey the water to a 6,000,000-gal. reservoir near the metallurgical plants.



Headframe and crushing plant at the main shaft

The Problem of Roasting Blende

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THE production of distilled zinc involves its extraction from zinc oxide, which, in turn, is usually obtained from sulphide zinc ores by roasting. Relatively high-grade ores are used, and the roasting is conducted at temperatures between 800 and 1,000 deg. C. Lower-grade mixed and complex ores are better suited for leaching and electrolytic precipitation, and are first roasted at lower temperatures—between 600 and 800 deg. C. Zinc ores are still roasted largely in hand furnaces, especially in Europe where labor is plentiful, because mechanical furnaces are not entirely successful in properly desulphurizing the ore in order to insure a good zinc yield. The difficulty of properly designing a good mechanical roasting furnace is partly attributable to the impossibility of roasting all kinds of blende satisfactorily in the same furnace, though some metallurgists maintain that even with a constant quality of ore, the difficulties are practically insurmountable.

In roasting blende for subsequent distillation, it is necessary to do so (1) as quickly, (2) as well, and (3) as cheaply, as possible. Traditionally, quick roasting means roasting at high temperature, but this results in sintering, formation of lumps not thoroughly roasted, production of ferrite, and loss of zinc by volatilization, as exemplified in work with the Spirlet and sinter furnaces. Otherwise, one must roast at low temperatures, and more slowly, as with the Hegeler or a hand-operated furnace. Economical roasting should, if possible, be rapid and yet at low temperatures.

If ores contain much gangue, especially if it is iron, sinter roasting will not produce any better product than a hand furnace, and, furthermore, it is more expensive and results in greater losses of metal.

The second point, as to the quality of the roast, involves eliminating the sulphide-sulphur of the blende at low temperatures, so that porosity will be retained, and yet preventing so far as possible, the formation of zinc sulphate.

Cheap roasting involves minimum labor requirements; least wear on the furnace, agitator, and other equipment; and low fuel consumption, using the heat released in the roasting process as efficiently as possible.

Quick, good, and cheap roasting can be done at relatively low temperatures if the roasting gases are guided toward the ore at higher speed. Such a process should bring the oxygen required for roasting to an increased number of blende particles; quickly remove the sulphur dioxide and the sulphur trioxide that forms zinc sulphate in the ore bed; and, by accelerating the roasting process, should reduce the amount of external heat required.

Economical roasting in hand-operated furnaces requires an expert workman with high physical endurance. The output is small and the roasting cost high. Conditions are totally different with mechanical furnaces, which may be considered of two types: those with a high fuel consumption (for example, the Hegeler furnace), and those, like the Spirlet furnace, which utilize the roasting heat to better advantage. Furnaces of the first type give a good porous product and furnace upkeep is fairly cheap, but they are not advantageous in other ways. The first-named furnace gives good results with easily roasted blendes, but is not satisfactorily efficient in the treatment of flotation concentrates, which are of increasing importance. The second type of furnace roasts fairly rapidly and has a fairly low fuel consumption, but maintains too high a temperature to make a satisfactory product. Another factor must be considered: mechanical furnaces work uniformly, without regard to changing conditions; they carry out the ore after a certain time whether properly roasted or not. Poor facilities are provided, moreover, for observing the roasting process, so that proper operation of the furnace is difficult. Facilities for accurate observation should be provided and the operator should be able properly to manipulate the furnace to suit conditions. Much can be told from the color of the roasting ore. If brighter than a normal roasting glow, the temperature is too high; if darker, too low. A pure glowing color indicates rapid roasting; but a murky glow, caused by the formation of gas, means slow roasting that should be intensified. Unsatisfactory functioning of the furnace is evident when the temperature on the lowest hearth rises and gas is formed on the rakes of this hearth.

A satisfactory furnace should have: (1) low roasting chambers; (2) a thin charge on the hearths; (3) a properly constructed stirring and conveying mechanism; (4) a suitable and sufficient air supply; (5) temperature control; and (6) efficient utilization of the heat of roasting.

The first point, low roasting chambers, insures rapid circulation of the atmosphere above the roasting bed. This should take place in all zones of the furnace, which is not the condition, for example, in the Spirlet furnace, owing to the necessity of arranging the marginal drop-holes inside. In the Leggo furnace the distribution of the roasting gas is so defective that all advantages obtained by the provision of low roasting chambers are lost. The effect secured by low roasting chambers can, however, be secured by other means, such as by fanning the gas against the ore. Rapid roasting at comparatively low temperatures and in a relatively small furnace can thus be secured. Also, owing to the rapid movement of the gases, formation of zinc sulphate can be largely prevented. Little trouble should be caused from zinc sulphate formation if the bed is thin and ventilation good, so that sulphur trioxide is removed as

Based on an article in *Metall und Erz*, translated by H. B. C. Hellmers, superintendent of the smelter department of the American Zinc & Chemical Company, Langeloth, Pa.

soon as formed, though flotation concentrate, being denser, offers more of a problem than coarser material. Low roasting chambers also favor fuel economy and a better utilization of the oxygen in the air or gas flowing over the ore.

Thin beds on the hearths insure relatively increased penetration of air into the ore. Excess heat is also quickly discharged, thus keeping the temperature down satisfactorily, even with rapid roasting. Thin ore beds mean a relative extension of the radiating surface of the ore, with a resultant possibility of speedier regulation of the temperature.

As to the third topic, the furnaces now in use are deficient in that they provide for interrelated stirring and conveying, so that if the speed of conveying ores that are difficult to roast is reduced, stirring is also reduced, which is undesirable. This can be overcome by inserting counter-rakes in the transport and stirring gear, retarding the transport of the ore but at the same time assuring proper stirring. Any harmful accumulations of ore can be prevented by short rakes, properly disposed over more than two arms to permit free progress of the ore, and by the leveling operation of the rabble arms as they revolve. In Spirlet furnaces, piled-up ore can be leveled down by means of "stripper stones." The rakes must be of suitable shape and size, for they are constantly in contact with the ore at the point where the oxidizing action is most intense and where the temperature is, therefore, the highest. They must not be too large, and must pass through the ore quickly.

The air supply to mechanical blende furnaces has heretofore been governed by natural draft, rarely supplemented by a fan. This results in fluctuations in the amount of air, with a constant charge of ore, an obviously undesirable condition, since it, in turn, affects the temperature and roasting conditions. The air supply, therefore, should be positive and adapted to the ore supply.

Proper temperature control in rapid roasting implies, first of all, that fresh air be supplied to the zones where the reactions are most rapidly proceeding, thus keeping their temperature down. Cold air also, because of its greater density, is necessary, in order to supply a sufficient quantity of oxygen to the roasting surface to make the reaction a rapid one. In round furnaces, the incoming air should be introduced at the center of the hearths, so that it can be distributed radially at once to insure uniformity of action. The gas-discharge pipe should be centrally arranged, so that the top hearth, where the blende enters the furnace, should be uniformly heated by the exit gas. The zones in the furnace where the reaction is proceeding more slowly should be supplied with small quantities of warm air, which will aid in maintaining the heat, and afford ample oxygen for the reaction.

The final point, involving fuel economy, suggests a weakness in the design of most present furnaces, which require a large consumption of fuel. Theoretically, the heat released in the roasting operation should make extraneous fuel unnecessary. Losses due to radiation and to the heat contained in the exit gases should be limited so that they will approach the amount of heat liberated in the roasting reaction. This can be done only by insulating the furnace wall or by providing it with a relatively small surface, keeping its temperature down so far as possible; and by the introduction into the furnace of sufficient, but not excessive, quantities of air.

All mechanical roasting furnaces are responsible for more or less flue dust, which, even though recovered, is not in a suitable form for further treatment. Dust can be lessened by bringing the ore to a red heat as soon as possible, at which temperature the ore agglomerates slightly, and by roasting in the smallest number of low chambers, thus decreasing the number as well as the height of falls between hearths.

The lead present in all blendes is in part volatilized during roasting, along with arsenic, antimony, and other impurities, and the degree of volatilization can be increased by increasing the temperature as well as by raising the velocity of the roaster gases over the ore bed. Good ventilation of the ore bed therefore aids in the removal of volatile metallic elements as well as furthering the elimination of sulphur trioxide. In a Spirlet furnace rebuilt by the author, operating on a lead-containing flotation blende concentrate, 60 per cent lead was present in the dust collected at the furnace. Thus is afforded a method of preparatory roasting, at proper temperatures and gas velocities, for the separation of lead and zinc, the gases being subsequently purified by electrostatic methods.

Dead-roasting in one step offers difficulties, and a two-step process is suggested, wherein the blende is first roasted down to about 8 per cent total sulphur, and then subjected to a second treatment on the sintering machine. Or the blende may be roasted to a very low percentage of sulphur and then mixed with coal. Such processes, however, have drawbacks, and it would probably be preferable to sinter-roast in a heated vessel, which would not involve zinc losses by evaporation or dusting, and there would then be only the question of driving off the last few per cent of sulphur and of disintegrating the zinc sulphate by removing the sulphur trioxide. With slow treatment, the temperature will not be too high, a low-temperature roast being a requirement met by the improved furnace suggested. Also, the material must be free from lumps. The sulphur dioxide gas passes off without difficulty.

In dead-roasting ferriferous blendes, formation of zinc-iron compounds that can be reduced only with difficulty is unavoidable, their formation being promoted by high temperatures and long roasting time, both of which are minimized in the improved furnace described. Professor Tafel, in *Metall und Erz*, has denied that zinc ferrites are difficult to reduce; perhaps the high temperatures, which are known to produce these ferrites, sinter the ore, and affect its reducibility in this way.

Leaching with dilute sulphuric acid requires a material from which the zinc can be dissolved easily but in which other metal oxides are difficultly soluble. Lower roasting temperatures than are necessary for dead-roasting—from 600 to 700 deg. C.—are therefore required. This results in an insufficient removal of sulphide sulphur, and formation of zinc sulphate, though a certain amount of sulphate is desirable.

Material to be leached should have three characteristics: (1) It must be porous (not sintered), and the zinc must be soluble, which means the ore must not be subjected to high temperatures that would form ferrite and silicate. (2) It must be absolutely free from sulphide sulphur. (3) Zinc sulphate should be present in quantity just sufficient to replace the loss of sulphuric acid. These three requirements are not realized in the ordinary roasting furnace, and even the improved type of furnace described will be deficient on at least one point. The constant temperature required for the elimination of sulphide sulphur from mixed ores is not always attainable, on account of the high roasting speed, even if one does not make use of the sulphur dioxide. With Wedge furnaces, on the other hand, using excess cold air, and liberating gases containing from 1 to 2 per cent only of sulphur dioxide, low roasting temperatures can be insured. The proper temperature is the most important feature in roasting low-grade mixed ores for leaching, and may be secured by eliminating excess heat through cooling the hearths by air circulated either by suction or by pressure. The warm air rising near the furnace may be used for hearth cooling, thus recovering a part of the heat lost by radiation.

Cooling the hearths will, however, seriously interfere with the speed of roasting, by lowering the temperature of the ore and by the resultant necessity of throttling the velocity of the roasting gas. This practically means that cooled hearths cannot be used in connection with high roasting chambers, in which the action of the roasting gas on the ore is insufficient anyhow. The disadvantages arising from cooled hearths can be compensated for by circulating the roasting air within the furnace so that the hot roasting gas is withdrawn from the top of the furnace and introduced again below. However, it is

preferable not to include the topmost roasting chamber in the circulation, on account of the formation of flue dust. Flue dust is a difficulty with furnaces with high roasting chambers, for such large quantities of roasting gas have to be moved that the particles of ore in the dropholes are picked up and carried away.

Such a circulation of roasting gas would aid the maintenance of constant temperature in the lower roasting chambers, owing to their being supplied with hot gas; would result in more rapid roasting within the zones of circulation, owing to the increase in gas velocity; would mean increased conservation of heat in the hearths that are thus cooled; would increase the sulphur dioxide and trioxide content of the roasting gases, and increase the formation of zinc sulphate; and, lastly, little extraneous heat would be needed for the furnace, as the final roasting on the lower hearths would be carried out with hot gases.

In view of the altered furnace conditions in a furnace of the type discussed in the foregoing, a study of the formation and decomposition of zinc sulphate is not out of place. The common assumption that zinc sulphate is formed by the reaction

$$ZnS + 2O_2 = ZnSO_4$$

is an error, for if this were true the zinc sulphate would form in those zones in which the most zinc sulphide is present, which is not so. Others claim that the following reaction holds, the sulphur trioxide being formed by contact action:

$$SO_2 + O = SO_3$$
$$SO_3 + ZnO \leftrightarrows ZnSO_4$$

and that a state of equilibrium exists between sulphur trioxide, zinc oxide, and zinc sulphate, which depends upon temperature, the reaction in the last equation proceeding to the left at high temperatures and to the right at low temperatures. To this I cannot assent. The foregoing equations explain the formation of zinc sulphate in zones containing much of the contact substance, iron oxide; and also explain the decomposition of zinc sulphate at high temperatures and its formation at low; but they do not explain a series of other phenomena which can always be observed during the formation of zinc sulphate in the furnace. If they were true, with the same temperatures and the same kinds of ore, exactly the same amount of zinc sulphate would form in the various types of furnaces, no matter whether the height of the layers remains constant or varies, which, as experience proves, is not true.

A more plausible explanation is that zinc sulphate, once formed, will not decompose below the temperature of initial decomposition of this salt, which is about 575 deg. C., and that, at this temperature, the presence of sulphur trioxide will lead to the formation of zinc sulphate, as it will at lower temperatures also, according to the last two equations. At higher temperatures, the zinc sulphate decomposes in increasing ratio as the temperature increases, reversing the last equation. It will also decompose more with increased ventilation of the ore bed, thereby liberating sulphur trioxide, and the decomposition will be checked if sulphur trioxide is freely supplied to the ore by the roasting gases, or is formed from sulphur dioxide in the ore bed itself and not freely liberated. To achieve the desired rapidity of operation, the temperatures within the furnace are always above the temperature at which the decomposition of zinc sulphate begins. The equation given,

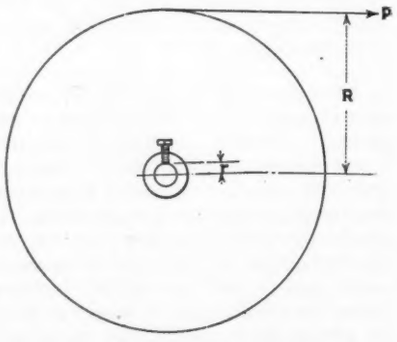
$$ZnO + SO_3 \leftrightarrows ZnSO_4$$

will tend to proceed to the left when the temperature is high and when the ore bed is well ventilated, and to the right when the temperature is low and when there is a free supply of sulphur trioxide. This equation explains, and supplements as clearly as possible, what has already been said about the prevention of formation of zinc sulphate in the dead-roasting of blende, and brings out that zinc sulphate formation increases when the temperature falls off, when the sulphur trioxide content of the roasting gases increases, and when the saturation of the ore by these gases is greater. It follows that high circulation of roasting gas in a furnace with low roasting chambers, and a constant low temperature, must inevitably cause the increased formation of zinc sulphate. This attempted mechanical solution of the roasting problem displaces a long contact between ore, sulphur dioxide, and sulphur trioxide, by a rapid circulation of the roasting gases over the ore. Even then, the formation of sulphate depends to a large extent on the physical and chemical properties of the various kinds of ores, some being more easily and more completely sulphatized than others. Maximum sulphatization will result from a long period of roasting, which will bring about an increased sulphur trioxide content of the roasting gases, owing to longer contact with the ore, and will prolong the time available for the formation of the sulphate. The sulphatization of the various kinds of ore can be varied at will within certain limits: with gases relatively high in sulphur dioxide the roasting period, and hence the period of sulphatization, as well as the sulphur trioxide content of the roasting gases, can be increased; with gases relatively low in sulphur dioxide, opposite conditions will prevail.

Why Setscrews Slip

AFTER a setscrew slips, no amount of tightening will prevent slip if the setscrew is too small. A slipping setscrew is too small or it is not tightened sufficiently, writes W. F. Schaphorst.

Setscrews are commonly called upon to pull too much. When one considers that belt pull P as shown in the accompanying sketch is usually in the hundreds of pounds and often in the thousands of pounds, and when one considers the great leverage it generally has on the setscrews, the wonder is that setscrews do not slip more than they do.



Setscrew diagram

To compute the force that a setscrew must resist:

1. Multiply the horsepower by the radius R in inches, and then multiply by 33,000.
2. If it is a belt drive, multiply the velocity of the belt in feet per minute by the radius r in inches.
3. Divide (1) by (2) to give the force in pounds the setscrew must resist.

If it is a gear or chain transmission, the same rule applies. The principal factors that need be shown are (1) the horsepower; (2) the velocity of the belt, chain, or pitch circle of the gear; (3) the radius R and (4) the radius of the shaft, r.

After knowing the force that the setscrew must resist, the following rule will be found useful to make certain that the setscrew is large enough: Extract the square root of the force in pounds and divide by 40. The result is the diameter of setscrew in inches. Or if you want greater refinement, use the table below.

Thus, for example, if you get 2,400 lb. as the answer, a 1-in. setscrew will be required according to the table; or two setscrews, each ¾ in. in diameter. The rule gives a setscrew 1¼ in. diameter.

d (in.) =	¼	5/16	⅜	7/16	½	9/16	⅝	¾	⅞	1	1¼	1½
P (lb.) =	100	168	256	366	500	658	840	1,280	1,830	2,500	3,288	4,198

GRADIENT CHART

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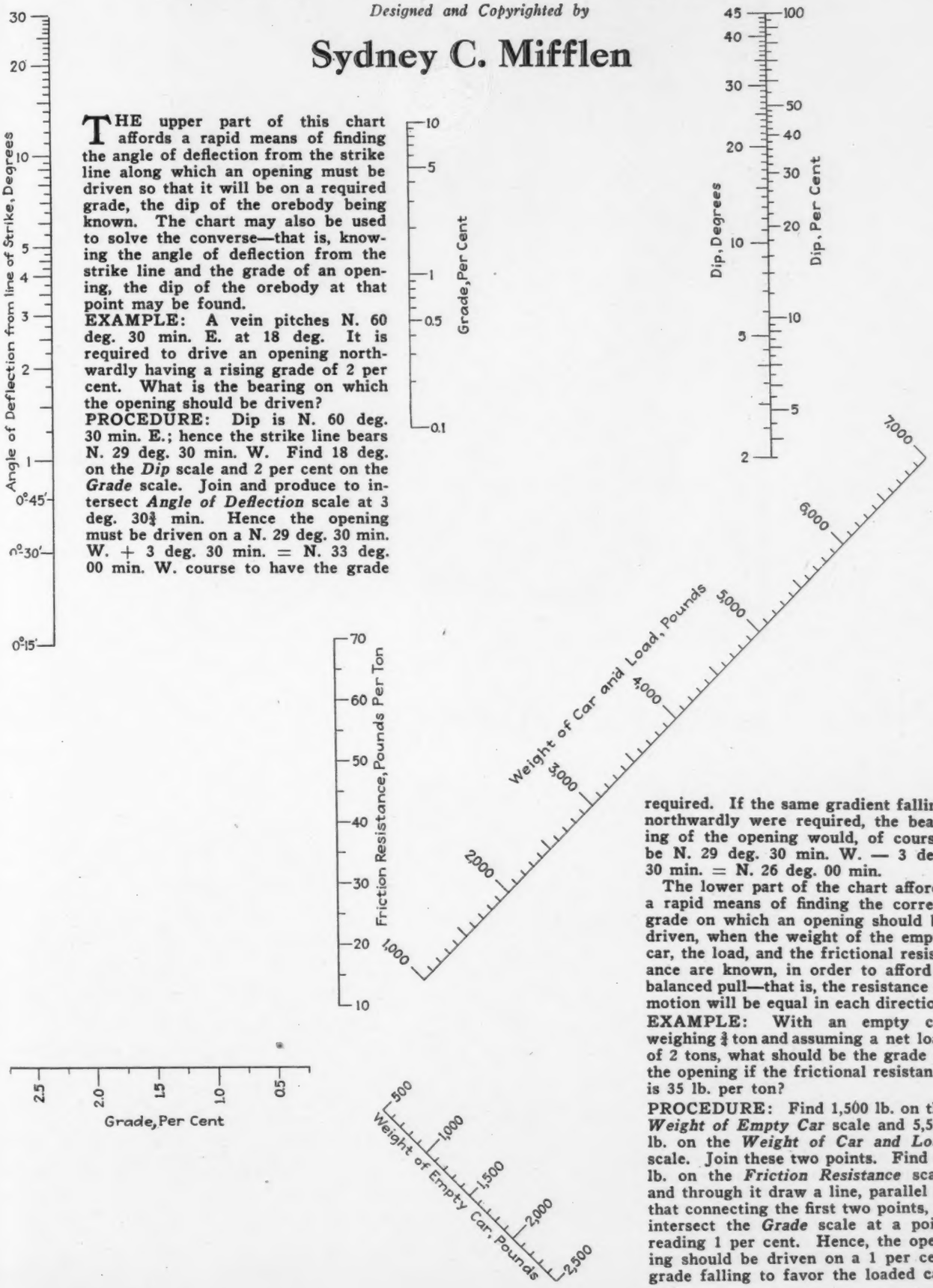
Sydney C. Mifflen



THE upper part of this chart affords a rapid means of finding the angle of deflection from the strike line along which an opening must be driven so that it will be on a required grade, the dip of the orebody being known. The chart may also be used to solve the converse—that is, knowing the angle of deflection from the strike line and the grade of an opening, the dip of the orebody at that point may be found.

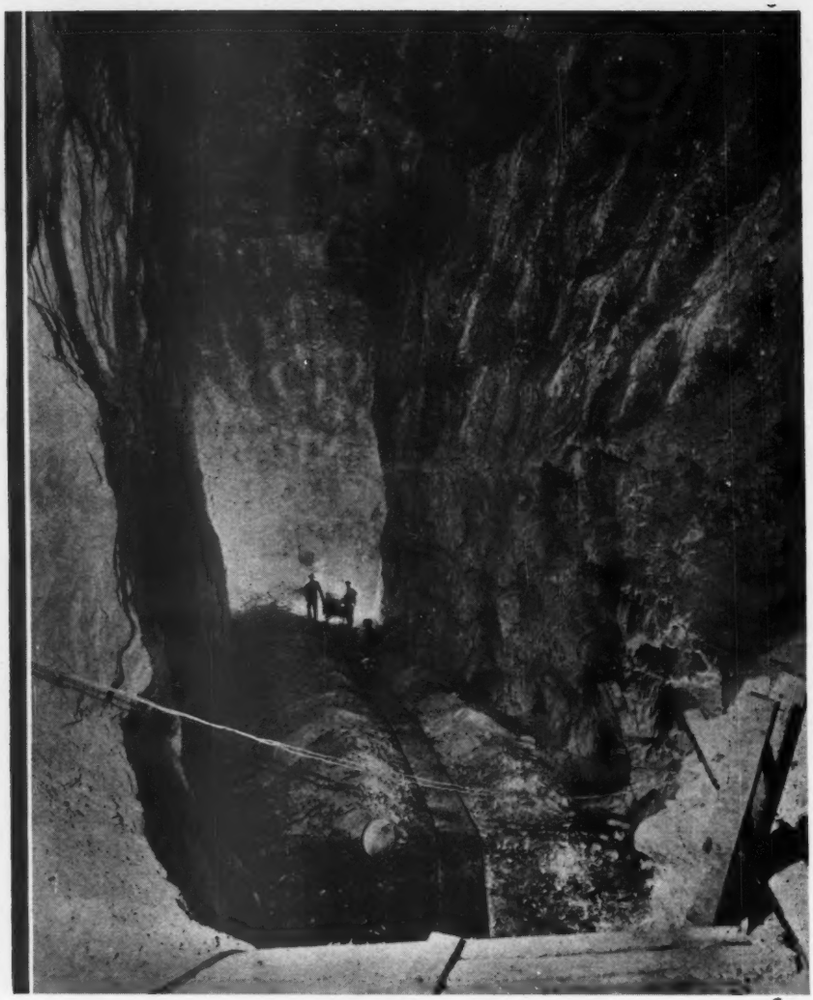
EXAMPLE: A vein pitches N. 60 deg. 30 min. E. at 18 deg. It is required to drive an opening northwardly having a rising grade of 2 per cent. What is the bearing on which the opening should be driven?

PROCEDURE: Dip is N. 60 deg. 30 min. E.; hence the strike line bears N. 29 deg. 30 min. W. Find 18 deg. on the *Dip* scale and 2 per cent on the *Grade* scale. Join and produce to intersect *Angle of Deflection* scale at 3 deg. 30¾ min. Hence the opening must be driven on a N. 29 deg. 30 min. W. + 3 deg. 30 min. = N. 33 deg. 00 min. W. course to have the grade required. If the same gradient falling northwardly were required, the bearing of the opening would, of course, be N. 29 deg. 30 min. W. — 3 deg. 30 min. = N. 26 deg. 00 min.

The lower part of the chart affords a rapid means of finding the correct grade on which an opening should be driven, when the weight of the empty car, the load, and the frictional resistance are known, in order to afford a balanced pull—that is, the resistance to motion will be equal in each direction.

EXAMPLE: With an empty car weighing ¾ ton and assuming a net load of 2 tons, what should be the grade of the opening if the frictional resistance is 35 lb. per ton?

PROCEDURE: Find 1,500 lb. on the *Weight of Empty Car* scale and 5,500 lb. on the *Weight of Car and Load* scale. Join these two points. Find 35 lb. on the *Friction Resistance* scale and through it draw a line, parallel to that connecting the first two points, to intersect the *Grade* scale at a point reading 1 per cent. Hence, the opening should be driven on a 1 per cent grade falling to favor the loaded car.



Stope No. 4 west level, McKay Seam Malagash Salt Mine, Malagash, N. S.

Photos Courtesy J. P. Messervey, Nova Scotia Department of Mines.

Non-Metallic Minerals in CANADA

M. F. Goudge

Mining Engineer, Mines Branch, Department of Mines, Ottawa, Canada

NON-METALLIC minerals are indispensable to most manufacturing industries. In fact, the industrial prosperity of any nation is largely dependent upon widespread resources of these important minerals. The necessity of coal and petroleum as sources of heat and power is apparent. The ceramic industry manufactures its wide range of useful articles almost wholly from non-metallic minerals; so too does the glass industry. Structural industries utilize principally non-metallic products such as cement, lime, gypsum, stone, sand, and gravel. The pulp and paper industry requires limestone, lime, sodium salts, and non-metallic fillers. The importance of common salt to the fishing and chemical industries and its necessity in foods do not require comment. Minerals used in the chemical industries are largely non-metallic. In the metallurgical industries, limestone, silica, and fluorspar are indispensable as fluxes, and magnesite, bauxite, soapstone, fireclay, graphite, and silica are the more important of the equally necessary refractory materials. In the rubber, paint, textile, tanning, and other industries, non-metallics find important applications, and the list could be extended almost indefinitely.

Canada is fortunate in its variety and abundance of non-metallic resources, which include most of the more widely used minerals—bauxite being a notable exception—and a great number of the more uncommon minerals such as lithium minerals, actinolite, uraninite, and so on. Furthermore, these resources, with the exception of coal, are well distributed both with respect to the present centers of population and to the needs of the future; also, they are served by efficient transportation systems. In most areas, cheap power, hydro-electric or steam, is available. All these are factors of importance in considering future development.

In 1929 the total mineral production of Canada, according to the official estimate of the Dominion Bureau of Statistics on March 1, 1930 (all produc-

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tion figures given in this paper are based on estimates and subject to revision), was valued at $307,146,494, to which the non-metallics contributed $153,452,191, or slightly under 50 per cent. These figures, impressive though they may be, represent merely the current utilization of the non-metallic mineral resources. They present no adequate picture of the resources available for utilization should the demand arise.

Coal has always been and probably always will be the basis of industry, and Canada possesses huge reserves of lignite and bituminous coal, which constitute a substantial proportion of the total reserves of the world. With such great resources it may seen surprising that imports of coal amount to slightly more than half the coal requirements of the country. The explanation of this apparent anomaly lies largely in the distribution of the coal in relation to population—the coal fields being along the Atlantic seaboard and in the western provinces. Intervening is a distance of more than 2,000 miles in which there is not at present a coal field of immediate importance. It is into this non-coal-producing territory, which includes the largest centers of population and industry in the Dominion, that the great part of the imported coal is delivered—chiefly from the United States.

In 1929, the production of Canadian coal mines of 17,502,355 tons, valued at $63,026,369, was slightly under the record tonnage of 1928. The production, in order of tonnage, was from Alberta, Nova Scotia, British Columbia, Saskatchewan, New Brunswick, and Yukon.

Petroleum and natural gas have been produced in Canada for the last 70 years; in fact, the first productive oil well in North America was one near Oil Springs, Ont., from which crude petroleum was obtained in 1857. Since that date the search for oil, actively pursued in many parts of Canada, has been attended by favorable results in Alberta, Ontario, and New Brunswick. As yet, however, only slightly more than 1 per cent of the requirements of the Dominion is produced from within the country.

During 1929, the oil and gas fields of Canada yielded 1,120,693 bbl. crude oil and naphtha, valued at $3,790,497, and 28,097,456 thousand cubic feet of natural gas, valued at $9,891,659.

The oil fields of southern Ontario reached their maximum petroleum production in 1894, when a yield of 829,104 bbl. was obtained. The peak yearly production of natural gas in this field—nearly 20,000,000,000 cu.ft.—was obtained in 1917. Since these dates the production has rapidly dwindled, and, apparently, these once-famous fields are nearing depletion.

In New Brunswick, both oil and gas are obtained near Moncton. The production has not so far been great, but the possibilities of this area are by no means exhausted.

Alberta is Canada's greatest oil-producing province, and it is here that the finding of additional oil fields is looked forward to with justifiable optimism. Indications of oil in the form of seepages are found in nearly all parts of the province. Three hundred miles north of Edmonton are the great bituminous-sand deposits, estimated to contain 500,000,000,000 cu.yd. of petroleum-saturated material. Just south of the provincial boundary, in the United States, are large producing oil fields. Two oil fields have been proved in Alberta to date—Turner Valley and Wainwright—and gas and oil have been obtained from wells at a number of other localities. An intensive search for oil is proceeding in many parts of the province.

The Turner Valley field, 40 miles south of Calgary, is the most productive oil field in Canada. This field came into prominence on Oct. 14, 1924, with the blowing in of the famous Royalite No. 4 well, which, previous to a partial plugging last autumn, was maintaining a steady production of 500 bbl. crude naphtha per day. Forty wells are now producing within an area 15 miles long by 1 mile wide, and the limits of the potentially productive area are not yet known. Thirteen of these wells came into production during 1929, including Home No. 3, the largest yet brought in, which, during the month of September, yielded at the rate of 780 bbl. per day, but is now producing about 500 bbl. daily.

The principal product of the field is a crude naphtha of about 73 deg. Bé., which is extracted from the wet gas, which most of the wells yield, by passing the gas through separators. The naphtha commands a much higher price than ordinary crude petroleum, and the field is a profitable one on that account. Petroleums of 30 to 37 deg. Bé. are also obtained, but in much smaller amounts.

During December, 1929, a daily average production of 2,130 bbl. of naphtha and 794 bbl. of crude oil was delivered to the refineries in Calgary from Turner Valley; and 956,681 bbl. oil and naphtha was delivered during 1929. This is an increase of nearly 100 per cent over 1928 deliveries.

A regrettable feature in connection with the Turner Valley field is the wastage of the natural gas after the naphtha content has been removed. The daily flow of gas from the wells has been variously estimated at 200,000,000 cu.ft. Of this, a maximum of 70,000,000 cu.ft. per day is used in Calgary and district for heating and for power purposes. The remainder is burned at a safe distance from the wells.

For a number of years, small quantities of crude oil have been obtained at Wainwright. In 1929, four wells in this field together produced 21,400 bbl. At Ribstone and at Red Coulee, near Coutts are other producing oil wells. Promising results are looked for from drilling operations now in progress at the latter field.

Natural gas has been found in many parts of Alberta. The cities of Cal-

Sodium sulphate deposit near Alsask, Sask.

gary, Lethbridge, Medicine Hat, and Edmonton, as well as many smaller places, utilize it for industrial and domestic purposes. In all fields other than Turner Valley, the gas is dry.

It is of interest to note that *helium* is found in most of the natural gases of Canada in quantities ranging from a trace to 8 cu.ft. per 1,000 cu.ft. of gas. This is the only known source of helium in the British Empire.

Asbestos to the amount of 306,055 tons, valued at $13,172,581, was produced in Canada during 1929. This, a new high record both for tonnage and value, represents about 70 per cent of the world production in tons. However, 92 per cent of this is of non-spinning grades. All of the Canadian asbestos is obtained from the Eastern Townships in the Province of Quebec, where six companies are engaged in production. The belt of asbestos-bearing rock extends for over 100 miles from Lake Memphremagog, on the International Boundary, to East Broughton, 60 miles south of Quebec City, but present production is confined to two areas, the principal one 26 miles long, centering on Thetford Mines, on the Quebec Central Railway, and the other near Danville, on the Canadian National Railways.

The asbestos is of the variety known as chrysotile, which for general purposes, is considered superior to all other varieties. It occurs either as veins or as slip-fiber within a great mass of serpentine rock, and is won by open-pit mining. The great proportion of fiber is less than $\frac{3}{4}$ in. long, and only rarely is 3-in. fiber obtained. All fiber over $\frac{3}{4}$ in. long is cobbed out by hand and designated as "crude"; this, forming only 1.5 per cent of the tonnage, accounts for more than 11 per cent of the total value. The remainder is freed from the rock by crushing in successive stages. At each stage all freed fiber is removed by air suction. After the fiber is cleaned of dust and separated into different lengths it is ready for manufacture into the numerous asbestos products.

A large proportion of the asbestos is shipped in the raw state, principally to the United States and to Europe, but increasing quantities are now being fabricated into various products in Canada. The products include building materials such as shingles, roofing papers, and asbestos boards; also brake linings, clutch facings, high-temperature insulation products, and asbestos packing.

Other promising deposits of chrysotile asbestos occur in Deloro and Bannockburn townships, Ontario, but no production has so far been recorded from these deposits.

As a producer of gypsum, Canada stands third among the countries of the world. The widespread distribution of the mineral in this country affords ample opportunity for increased production. At present gypsum is quarried or mined in Nova Scotia, New Brunswick, southern Ontario, Manitoba, and southern British Columbia. Large deposits as yet unworked occur in these provinces and also in the Magdalen Islands, northern Alberta, the North West Territories, and on some of the Arctic islands.

The high grade of the gypsum, coupled with the extensive deposits on tidewater in the Maritime Provinces, has resulted in an extensive export trade being developed, principally with the United States, and three-quarters of the Canadian production of crude gypsum is exported each year. Total production for 1928 was 1,246,368 tons, valued at $3,743,648. Estimated production for 1929 is 1,211,383 tons, valued at $3,338,859. The increase in the utilization of this important structural material has been marked in recent years. Production for 1929 was almost double that of 1924.

Limestone quarry, Pacific Lime Company, Blubber Bay, British Columbia

Plants engaged in the manufacture of gypsum products are situated in Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, and British Columbia. The chief products are calcined gypsum, wallboard, and gypsum blocks. As plaster of paris, it is used in making molds and casts for various purposes. Raw or crude gypsum is used principally as a retarder in portland cement, as land plaster, and in the production of terra alba, used in the paper, paint, and textile industries.

Rock salt occurs in Nova Scotia, New Brunswick, Ontario, and Alberta. Brine springs are known in Manitoba, Saskatchewan, and in the provinces previously mentioned. At Malagash, Nova Scotia, the only salt mine in Canada is worked in a deposit which comes to within less than 10 ft. of the surface. Parts of this deposit are pure, and the material needs only crushing and screening before being marketed as coarse salt. A large part of the output from Malagash is used in the fishing industry, and for this purpose has been found superior to the salt obtained from sea water. About 30,000 tons was mined in 1929. In southern and southwestern Ontario, salt brine is obtained from wells drilled into thick beds of rock salt, which lie from 1,000 to 2,000 ft. beneath the surface. Crystal salt for domestic and other uses is obtained by recrystallization from the brine, and large quantities of the brine itself are used in the chemical plants of the district. A small production of salt has been made at various times from brine springs in Manitoba, Saskatchewan, and Alberta. Rock salt was encountered in Alberta at a depth of 631 ft. during drilling operations in 1920 at McMurray. The salt industry in Canada has shown a steady growth. Production in 1929, 330,264 tons, valued at $1,578,086, is the highest on record.

The uses of salt, aside from its indispensable function in the seasoning and preserving of foods, are largely in the chemical field, where it is an important raw material entering into the manufacture of hydrochloric acid and various sodium compounds. Quantities are also used for refrigeration, in ceramic glazes, and in some non-ferrous metallurgical processes.

Limestone occupies an important place among the mineral resources of Canada, and there is available within the Dominion a variety of limestone for practically every use to which limestone is put. In 1929, according to estimates, about 12,000,000 tons of limestone was quarried, which when made into the primary products, such as lime, cement, and stone for various

purposes, had an initial selling value of $33,000,000.

The resources of limestone are well distributed with respect to present and prospective consuming centers. Deposits of pure high-calcium limestone are worked in every province except Prince Edward Island and Saskatchewan. Dolomite and magnesian limestone are produced in Nova Scotia, New Brunswick, Ontario, and Manitoba, and deposits of pure dolomite are available, but not at present worked, in Alberta and British Columbia.

Marble is produced in Quebec, Ontario, Manitoba, and British Columbia, and there are a great many undeveloped prospects in these and the other provinces. The largest marble quarry is at Philipsburg, Que. The newest marble quarry is on the Hudson Bay railway, 40 miles north of The Pas, Manitoba, where a deposit of rose-colored marble is being developed.

Building stone of good quality is produced at St. Marc des Carrieres, Que.; in the Montreal district of Quebec; in the Niagara peninsula, Ontario; at Tyndall, Man.; and at a number of other places. The buff, mottled Tyndall limestone vies with marble as an interior decorative stone.

Limestone for flux, and for use in paper mills and in a great variety of chemical industries, is being quarried in increasing amounts each year.

The Canadian lime industry has during each of the last five years established a new high record of production. The estimated lime production for 1929 is 590,174 tons, valued at $5,288,351. At present about 65 per cent of the lime produced in Canada is consumed by chemical industries. Owing to the steady expansion of the present chemical industries and to the prospects for the establishing of new industries requiring lime in their processes, the prospects of the lime industry in Canada are decidedly promising.

The *portland cement* industry in Canada has been showing an almost steady increase in production since 1921, culminating in a record production of 12,284,081 bbl., valued at $19,339,244, in 1929. Cement plants are operated in Quebec, Ontario, Manitoba, Alberta, and British Columbia. The wet process of cement making has found increasing favor of late years, and several Canadian plants have been re-designed to use this process.

Clays, abundantly distributed throughout Canada, range in type from the common surface clay to china clays, the latter being found only in Quebec, Ontario, and British Columbia. Ball-clays of a quality suitable for use in compounding porcelain are found in Saskatchewan. Stoneware and earthenware clays occur in Nova Scotia, Saskatchewan, and Alberta. Fireclays and surface clays are abundant in all the provinces. Sewer-pipe clay is found in all the provinces except Prince Edward Island, Quebec, and Manitoba. Based on these clay resources is an important ceramic industry comprising 185 firms with a total invested capital of well in excess of $30,000,000 and operating 194 plants extending across the whole Dominion. In 1929, the total value of the products of this industry was more than $13,000,000. Production was largely composed of various types of brick, structural block, sewer pipe, tiles, pottery, firebrick, and refractory shapes.

Sand and gravel are seldom included in a discussion of the mineral resources of a country, yet they are of great value in the construction of highways, railways, and as aggregate in concrete. Both sand and gravel are available in quantity in every Canadian province except Prince Edward Island. It is estimated that 28,102,917 tons of these materials, valued at $5,809,431, was used in Canada in 1929.

Molding sands of various types are much more plentiful in the Dominion than is generally known, and domestic requirements could doubtless be supplied from these deposits.

Silica, in the form of silica sand, sandstone, quartzite, and quartz, is a non-metallic mineral of wide distribution in Canada. It has an important field of usefulness in the manufacture of glass, ferrosilicon, silica bricks, and as flux. Smaller amounts of finely pulverized silica are used in the paint and ceramic industries. The greater part of the Canadian production of silica is in the Eastern Provinces, principally from deposits of quartzite and sandstone. Quartz is also produced in conjunction with feldspar quarrying. Very little Canadian silica is utilized in the domestic glass industry, in large measure because of competition from Belgian glass sand. In 1929, an estimated total of 280,000 tons of silica, valued at $500,000, was produced in the provinces of Nova Scotia, Quebec, Ontario, Manitoba, and British Columbia.

Feldspar deposits are of common occurrence in the areas of Pre-Cambrian rock throughout Canada, but production is confined to the provinces of Ontario and Quebec. The potash variety is the only type mined. Some of the deposits are a considerable distance from railway transportation; but, owing to the high quality of the feldspar produced, prices are such as to make operations profitable. In 1929, estimated production was 37,353 tons, valued at $343,149. By far the greater part of the Canadian production is exported in the crude form to the United States. Grinding plants, capable of producing a finely ground spar, suitable for use in ceramic industries, are at Toronto and at Kingston, Ont. Recently, a bottle-glass plant has been erected at Oshawa, Ont., which uses feldspar as the principal raw material.

Closely associated with feldspar in occurrence is *mica.* This mineral too, occurs in the Pre-Cambrian rock in many parts of Canada, but the only producing localities are in Ontario and Quebec. The variety of mica produced is amber mica, or phlogopite, and Canada is the largest producer of this variety. Deposits of white mica and of black mica are also known. Estimated production in 1929 was 4,000 tons, valued at $120,000, the major part of which was from three or four properties. The deposit of mica at Sydenham, Ont., is one of the largest in the world. Production of both mica and feldspar could be greatly increased should the demand arise. The mica as mined is shipped to trimming plants, where it is prepared for domestic consumption or for export to Great Britain and the United States. Almost all the Canadian mica is consumed by the industries manufacturing electrical equipment. For this purpose, scrap mica is principally required. This part of the output is much more easily disposed of at a satisfactory price than is the sheet mica.

Graphite occurs widely distributed in Canada. Production has been made from such widely separated points as Nova Scotia, Ontario, Quebec, Baffin Island, in the Arctic, and from British Columbia. Present production is from Ontario and Quebec. Flake graphite is the only product. The total production of graphite in Canada for 1929 was 1,461 tons, valued at $103,174. Almost all of this was exported. Present market conditions are none too good, owing to the competition of the much more cheaply obtained graphite from Madagascar and also to the falling off in demand for graphite crucibles. Formerly, from one-half to three-fourths of the graphite production was consumed in the manufacture of crucibles. Foundry facings, lubricants, pencils, paints, and stone polishes comprise the other main uses. Artificial graphite, made in electric furnaces, also produced in Canada, competes with natural graphite.

Production of *magnesite* in Canada is entirely from the Grenville district,

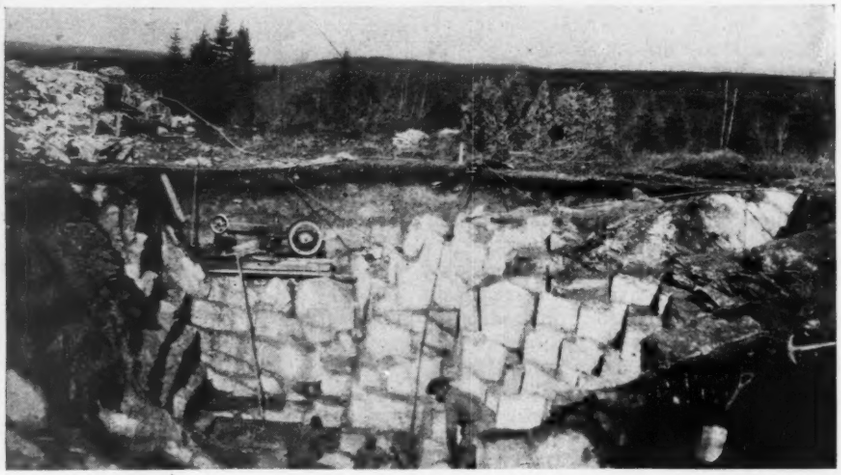
Argenteuil County, Que. The Grenville magnesite deposits, which are crystalline in character, occur as replacement bodies in Pre-Cambrian dolomite. The entire production is dead-burned magnesite for use as a refractory material, principally in steel

Ribbon structure of chrysolite asbestos, Eastern Townships, Quebec

plants. Production during 1929 was 18,701 tons, valued at $491,170. Earthy hydromagnesite occurs in British Columbia. Deposits of this material near Atlin were operated during 1915 and 1916, but have not been worked since the last-named year.

Talc and soapstone deposits have been worked in Nova Scotia, Quebec, Ontario, and British Columbia. The present Canadian talc-mining industry is centered at Madoc, Hastings County, Ont., where two mines and mills are in operation. The talc, which is exceptionally high grade, occurs as lenses in a dolomitic limestone. Soapstone blocks are produced at Eagle Lake, near Vermilion Bay station, on the C.P.R. (Kenora district), Ontario, and also from Robertsonville, Megantic County, in the Eastern Townships of Quebec. The blocks are used in sulphate-pulp mills to line the soda-ash smelting furnaces. Soapstone, also used where an acid-resisting material is required, has many applications in the manufacture of electrical appliances. Talc has a great variety of uses, but most of the production is consumed as a filler in paper and paint manufacture, and as a surfacing material in asphalt roofing paper. The greater part of the Canadian talc production is exported after grinding. The estimated value of production of talc and soapstone in 1929 was $229,208.

Natural abrasives, including corundum, garnet, and sandstone, are available in many localities in Canada. No production of corundum or garnet is now being made, but the former mineral is available in quantity at Craigmont, Ont., where it was formerly mined. Garnets are found in a great many places throughout the Dominion, but production has been confined to one deposit near Bancroft, Ont. Development work has recently been done on two garnet properties in Quebec, but no production is recorded. Sandstones suitable for manufacture into pulpstones, grindstones, and scythestones are found in New Brunswick, Nova Scotia, Quebec, Ontario, and British Columbia, but continuous production of these articles is maintained only in New Brunswick, where the 1929 production amounted to 1,248 tons, valued at $48,389. Artificial abrasives have greatly cut into the market for all the above-mentioned natural abrasives with the exception of pulpstones. The demand for pulpstones is steadily increasing, but as yet Canada produces only about 5 per cent of the pulpstones used in Canadian mills.



Quarry and sawing plant of Robertsonville Soapstone Quarry Company, Megantic County, Quebec

Diatomite deposits occur in practically all parts of Canada. The present outlook for production of this material is brighter than it has ever been, owing to a wider appreciation of its value as an insulating material, as a filtering medium, and for admixture with concrete. The 1929 production of about 500 tons was shared equally between two companies, one operating at New Annan, Nova Scotia, the other at Quesnel, British Columbia. The Quesnel deposits have a maximum thickness of 60 ft. and are the largest known in Canada. Production from the diatomite deposits at Digby, Nova Scotia, and at Martin Siding, in the Muskoka district of Ontario, is expected in 1930.

Extensive deposits of *volcanic dust,* from 2 to 30 ft. thick, occur at several localities in Saskatchewan and British Columbia. The dust, yellow in color, is consolidated into soft strata, and has a content of 60 to 75 per cent silica. Near Swift Current, Sask., a large deposit has been worked for the last few years. The material is used in cleansers and scouring powders. There are possibilities of marketing the volcanic dust for use as a road-surfacing material and as an admixture in concrete to increase its workability. Volcanic dust is also a mild bleaching agent. Recently it has been found that it has the property of adsorbing certain dyes from solution, and this opens up possibilities for the making of colored pigments. Preparations are being made by two companies to market the material for these various purposes. About 300 tons of volcanic dust, valued at $6,000, was produced in 1929.

Bentonite, a peculiar clay-like material, occurs at several places in western Canada. Some of the deposits are 10 ft. thick. It is regarded as being possibly an alteration product of volcanic dust. It has many peculiar physical characteristics, which may ultimately render it a material of considerable value.

Sodium sulphate in the form of glauber's salt is found principally in Saskatchewan. Core-drilling of eighteen deposits by the Mines Branch, Department of Mines, Ottawa, has resulted in the proving up of quantities in excess of 115,000,000 tons. No production is recorded prior to 1920, but from then until 1928 annual shipments of from 504 to 6,775 tons of both the natural and the dehydrated sodium sulphate (salt cake) have been made. Three companies are producing at present, and during 1929 the construction of a large plant for the production of salt cake was begun at the Horseshoe Lake deposit, near Ormiston, Sask. Shipments are expected to begin in 1930, and a contract has already been made to supply 25,000 tons of salt cake per year to the International Nickel Company. Large quantities of sodium sulphate are consumed by the chemical, metallurgical, glass, and pulp and paper industries, and probably in the near future these natural deposits will make an important contribution to the sum

total of the non-metallic mineral production of the Dominion.

Natural *sodium carbonate* (washing soda) is being obtained from a series of small deposits along the Pacific Great Eastern railway north of Clinton, B. C. The material is very pure. At present the output is marketed in the form in which it is obtained from the deposits, but plans have been made to convert part of the production into soda ash.

There are small deposits of *magnesium sulphate* in British Columbia, near Ashcroft, and also south of Penticton. At Dana, Sask., is a large alkaline lake, in which magnesium sulphate is an important constituent of the brine. There is no production from these sources at the present time.

Iron pyrites, classed as a non-metallic mineral, is available in many parts of Canada. The mining of pyrites as a source of sulphur, for the manufacture of sulphuric acid, and also as a source of sulphur dioxide gas for use in the process of manufacturing sulphite pulp, was once an important industry in Canada, but of late the major production of pyrites has been as a byproduct in connection with the mining of copper, lead, and zinc, the pyrites being obtained in the concentrators during the separation of the metals. Canadian production of pyrites in 1929 was 77,258 tons.

Actinolite is a mineral of which Canada is perhaps the sole world producer. It is exported to the United States, minerals, including lepidolite, amblygonite, and spodumene, is found in Manitoba 100 miles north of Winnipeg. The deposit, under development by the Silver Leaf Mining Company, gives promise of yielding a considerable tonnage of lepidolite and spodumene. Lepidolite is used for certain varieties of glass. Spodumene and amblygonite are a source of lithia salts.

The prospects that Canada may become a producer of radium were enhanced during 1929, when an apparently important deposit of *uraninite* was discovered near Wilberforce, Haliburton County, Ont. Active development work is now in progress.

Iron oxides for use in the manufacture of paints are produced chiefly in the Province of Quebec. Total production for 1929 was 6,518 tons, valued at $115,932.

Production of *phosphate* in Canada bids fair to increase greatly within the next few years, after being practically negligible since 1915. This will be the result of recent developments in British Columbia, whereby deposits of low-grade sedimentary phosphate are to be utilized on a large scale by the Consolidated Mining & Smelting Company in the manufacture of a triple superphosphate fertilizer. Aside from these sedimentary phosphate beds in the Crow's Nest Pass area, extensive deposits of *apatite* occur in the vicinity of Buckingham, Que., and in Frontenac and Lanark counties, in Ontario. These deposits once yielded an important part of the world's production of phosphate.

Open pit at Richardson mine of Kingston Feldspar & Mining Company, Frontenac County, Ont.

where it is used in the manufacture of roofing material. The maximum production of 550 tons was attained in 1902. In 1929 only 30 tons, valued at $375, was shipped. The deposits, in Hastings and Addington counties, in Ontario, are large, one being in the form of a lens a mile and a half long and 600 ft. wide. The actinolite is of the fibrous type.

An interestnig deposit of *lithium*

Barite has been mined in Canada for upward of 60 years, but steady production has been maintained from only one deposit—that at Lake Ainslie, in Nova Scotia, and from there only in small quantity. Barite deposits have been worked at several other localities in Nova Scotia and also in Quebec and Ontario. Occurrences are also known in the Spillamacheen district, British Columbia. Many of the deposits are high grade and of large extent.

Mention should also be made of the large quantities of granite, sandstone, slate, andesite, and other materials available for various purposes, production of which during 1928 amounted to 1,296,761 tons, valued at $2,590,182.

Many other non-metallic minerals, including chromite, anhydrite, fluorspar, rutile, ilmenite, titanite, beryl, and celestite, are available in Canada, production of which is either very small or, for various reasons, has ceased entirely, but they constitute resources of great potential value for future requirements.

■

Diagram Simplifies Changing Scale Dimensions

PLANS must sometimes be redrawn to a different scale. If the job is a big one, with many small details to be drawn in, and a pair of proportional dividers is not available, the work becomes tedious and much time is wasted.

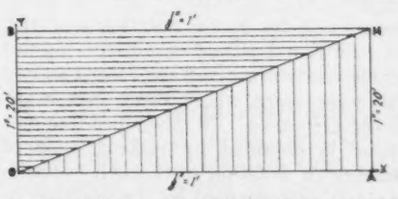
A method that has been used to good advantage is a diagram similar to that shown in the sketch. The diagram may be constructed as follows: From point *O* draw horizontal line *OX*. At right angles to *OX* from point *O*, draw *OY*. From the scale on the old drawing measure off a distance *OA*. Erect a perpendicular *AM* equal on the scale of the new drawing to *OA* on the scale of the old drawing. Draw line *OM*. Erect perpendiculars, conveniently spaced, from *OX* until they intersect the line *OM*.

To use the diagram, set the dividers to a line of given length on the old drawing. With the dividers set in this position, set one point at *O* on the diagram. Let the other point fall on *OX*. From this point on *OX* swing the dividers until they form a perpendicular with *OX*. Shorten (or lengthen) the setting until the free end intersects *OM*. This setting is the length of the line on the new scale.

The perpendiculars to *OX* are guide lines properly to locate the correct position for the dividers where they intersect *OM*. These guide lines may be colored alternately to prevent confusion

If horizontal lines are drawn from *OY* to an intersection with *OM*, the reverse change in scale can be made by using *OY* as the base. This is indicated in the figure where the change can be made from $\frac{1}{8}$ in. = 1 ft. to 1 in. = 20 ft., or vice versa.

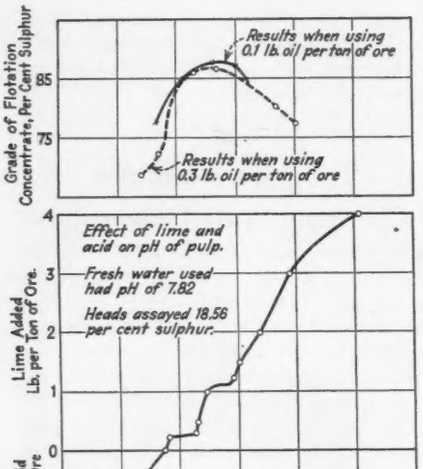
—E. F. SEAMAN, in *Power*.



Horizontal lines represent dimensions at one scale; vertical lines, the same dimensions at a different scale

The pH Value in Flotation, and Maximum Profit

H. L. Hazen



The pH factor compared with grade of concentrate and tailing and amount of lime or acid added

TECHNICIANS know that the pH factor of a flotation circuit is just as important as any of the other variables; that the maximum profit from an ore concentrated by flotation can be obtained only by first deciding what pH value gives the best results and then holding the flotation circuit to that particular factor.

Recently I had occasion to determine the critical pH required by a certain ore of elemental sulphur. Because of marketing conditions, sulphur concentrate should contain more than 85 per cent sulphur.

When discussing the matter with Mr. B. L. Trost, who is in charge of the experimental department for the manufacturer of the Kraut flotation machine, he said that I would obtain the highest grade concentrate and the lowest tailing "at some point where there is a break in the pH curve." It developed that this curve is obtained by making a large number of flotation tests, each succeeding test accompanied by the addition of an increasing quantity of lime, and the pH of the tailing water accurately determined for each test. A line is then plotted, using the amount of lime and the pH reading as co-ordinates. At one or more points this line will probably make a reverse curve, and the best flotation results will be obtained when the pH value is the same as at one of the points where a reverse curve starts. Mr. Trost based his prediction on the results of work he has done on many different ores of copper and zinc.

The tests I made to locate the critical pH value are plotted in the accompanying diagrams. Each test was made on different portions of the same sample of elemental sulphur ore containing 18.56 per cent sulphur. Lime was added in solid form to the charge while grinding wet in a ball mill. Each charge was ground for five minutes, floated for four minutes, and re-treated once. No special effort was made to obtain a high-grade concentrate. All pH determinations were made with a potentiometer manufactured by Leeds & Northrup. To the best of my ability I made each test in exactly the same manner. Three tests were made in which sulphuric acid was added to the pulp instead of lime. The results checked the results obtained in a 200-ton mill.

The highest-grade concentrate and the lowest tailing were obtained close to the reverse curve obtained between the pH values of 7.6 and 8.0. After allowing for small experimental errors I believe the results checked the prediction.

Another phenomenon indicated by these tests is that the loss in the tailing is highest at those points where an increase in lime causes a relatively small increase in the pH value of the circuit.

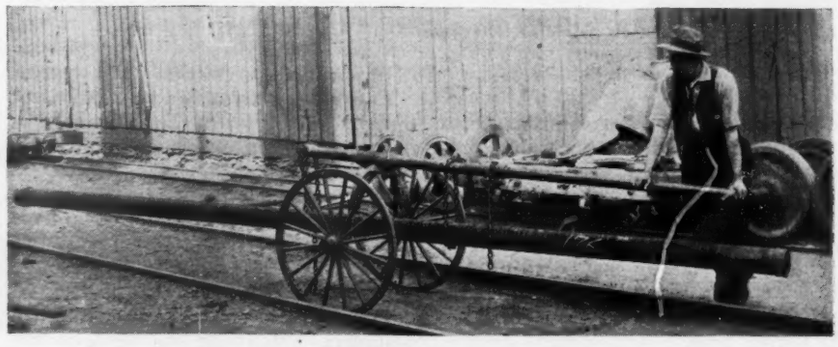
I am unable to offer any satisfactory explanation of the causes of the results detailed in the foregoing.

Truck Handles Material Cheaply and Safely

ON ANY maintenance job, tools must be provided that are well fitted for the kind of work to be done. Some foremen do not limit themselves to standard tools of general application. They complete the assortment by making up special tools for certain jobs. W. H. Bell, in *Coal Age,* describes a material-carting truck he built to avoid calling for six or eight men whenever he needed to transport heavy material a short distance to a repair job about the plant. The truck is shown handling a 4-in. pipe.

The wheels and axle, the latter bent into an inverted "U," were taken from an obsolete horse-drawn ambulance. The tongue is welded to the axle, and one end of each lifting chain is welded to the tongue. Opposite each chain weld is a heavy forked hook to which the chain is fastened to form any length of loop.

When a piece of pipe or shafting, a locomotive axle, or similar material is to be picked up, the tongue is raised as high as a man can reach and the rear chain is looped around the load to be carried, at a point near its center of gravity. The tongue is then pulled down, and the front chain attached so as to balance the load.



Strong backs displaced by narrow-gage truck

CHANGE:

Its Significance to Engineering and Economics

TO BE PERMITTED to join with you in this celebration of fifty years of distinguished service by the American Society of Mechanical Engineers is a great privilege. I have the honor of bringing to you the felicitations of the engineering press, of saying "Well done" on its behalf, of wishing you godspeed for the future.

A special business of the engineering press has been that of an observer of engineers and their activities. In that capacity it has watched you and your work from the viewpoint of the critic. It has counseled, suggested, commended. Frequently, it has been a partner with you in your enterprises. Always it has been an appraiser. Its words, then, come with all the more weight as it joins in this celebration. Its congratulations, its admiration, its praise, are born of fifty years of intimate knowledge, fifty years during which it has lived by your side as friendly neighbor, friendly critic.

To cast one's mind back over the half century brings a veritable flood of impressions, but brevity demands the selection of only one or two items for consideration. Without attempting, therefore, to appraise them, in comparison with other developments, let me direct your attention briefly to two outstanding features in your history, to one of them because it will affect deeply the work and outlook of the engineer in the future, and the other because your past performance holds brilliant promise for the coming years. The first of these features is the rapidity of acceleration in engineering; the second, the special character of the social contribution made by the mechanical engineer.

Very striking, indeed, is the steady increase in the rapidity of engineering progress. Change has always been with us. Under the guise of desire for improvement, it has probably always been a spur to the human race. In fact, improvement and change are inseparable from growth and development, whether intellectual or material. The feature that I emphasize as a striking phase of our recent engineering history is not a difference in kind, but in rate, in speed, in the acceleration, of engineering development and progress.

How rapid has been that acceleration need hardly be detailed to a group of engineers and industrialists. It has been a fact in your lives. Let us note briefly that the curves of development are invariably parabolic in form. The rate accelerates constantly with the years. This is true, for example, of such developments as the size of steam turbines, the power applied through electric motors, the indexes of primary power employed, of physical production, of production per worker. Be it noted that these are all indexes of change. Growth in size involves new problems and new solutions. Growth in extent of use requires new features to adapt the process or power to the new field of application.

Should we need further evidence of speed of change we can find it in the summary of research activities made by the Engineering Division of the National Research Council. Of 599 firms carrying on research activities, 67 per cent report improved products or services; 59 per cent, reduction in production costs; 40 per cent, development of new fields of application; 30 per cent, by-products and new materials; 8 per cent, new products. Each item entering into these reports indicates an engineering change.

Recall, too, the revolutions in machine shop and in foundry practice since the War; the speed of development of gas and electric welding; the partial crowding out of castings by stampings and forgings; the progress in ferrous and non-ferrous alloys; the improvements in petroleum refining; the hundreds of new chemical products; the new devices that the electrical industry offers annually to the manufacturer and the public. If we want to dwell on the quintessence of change, however, we can find it in the radio art, where each year for nearly ten years has witnessed a radical advance.

Nearly always, to repeat a former phrase, whether we study progress in consumer or in producer goods, the curve of change is parabolic. In fact, the ordinates shoot off the plotting paper; but note that they do so, in part, because we overvalue our own contribution and undervalue the possibilities of future achievement.

Despite the fact, however, that we engineers are part and parcel of this era of rapidly accelerating change, one of the chief agents thereof, our acceptance of change has been passive. We have not accepted it as a cardinal element in policy. We have not sensed its compelling character. We have believed in change in theory, for we were apostles of improvement. In practice, our pace has been accelerated largely by outside forces—by salesmen, executives, and the public—rather than by our own keen conception of the place that change had come to accupy in American life and business and, therefore, had to occupy in American engineering. If we are to play the rôle that should properly be ours, we must accept rapid change as a principle in our planning. Its insistence must be recognized and be ever present in our consciousness. We must realize that the present rapidity of change is coloring the whole nature of engineering and of business, giving them a new present life and a new outlook.

The all-important point is that the factors which are forcing change upon us are virile and of a continuing nature. Fundamentally, they are, first, our production of surplus wealth; second, the optional purchasing power of the public.

Surplus wealth above what is needed for living, flows, in too large a volume, into productive enterprise and causes an excess of production capacity. Producers, as a result, try to differentiate their products from

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Address at the Fiftieth Anniversary, American Society of Mechanical Engineers, New York, by Edward J. Mehren, Vice-President, McGraw-Hill Publishing Company, New York.

those of other manufacturers so as to avoid competition between goods as much as possible. Consequently, there is change, constant change.

Operating in the same direction, toward constant change, is the increased purchasing power of the public. Wages, salaries are more than sufficient for millions of Americans for a bare living; consequently, they have a margin for "optional purchases," in which, free from the money-pinching that is necessary when funds will stretch only for bare necessities, the purchaser can demand that which will most nearly satisfy his needs, his taste, or his whim. In such a mood, his choice goes constantly to the new. While, therefore, the producer, in his anxiety to capture the consumer's dollar, puts on a pressure for new goods, the consumer of his own volition increases the pressure. There is thus a push from the producer and a pull from the consumer. Moreover, if you have faith in the fundamental soundness of American economic development and in the bases on which it rests you must conclude that these factors will continue operative long after you and I have passed on to a world of greater marvels.

The instruments used by the producer in meeting this need for change are two in number, the style appeal and research, the one being the most insubstantial element affecting production; the other, research, the most substantial. Both meet in the hands of the engineer and are joined by him with other elements into the creation of practicable and salable products. In this connection, let me remind you of the vivid characterization of research by C. F. Kettering when he said that a research department is to him only a department of systematic change, and here, in that phrase, lies the whole essence of the idea that I wish to emphasize.

Evidently such conditions, affecting in an important way the enterprises to which he gives his life, must enter importantly into the engineer's planning of his policies and outlook. There is need on his part for sympathy with change; for sympathy with the humans who demand it, and whose demand creates new opportunities for him. There is need for flexibility, that he may adapt himself to the conditions that it creates in his production enterprises. There is need, above all, for the most solid preparation for his work; for all this change, no matter how valid, has a tendency to rip one from solid moorings, to cast one into a sea of insubstantial flounderings, where principles will be sluffed and disaster is the sure consequence. All the more reason, then, for soundness in engineering education and preparation, that while sympathizing with change, while serving it and seeing that it serves him, the engineer will be a conservative force, guiding the change into sound rather than unsound directions—directions sound in engineering and sound in economics.

Most important, too, is the need for vision, so that the engineer may be able to sense the direction in which demand is surely headed; so that, by study and experiment and research, he may anticipate the demand and be ready to serve it when the public, becoming conscious of its need, begins to call for new goods in the market place. Obviously, what I have said of goods applies as well to services—to transportation, communication, electric power supply, and public works.

This, then, is one of the major developments that the publisher sees in the last fifty years—a rapid acceleration in the rate of change in engineering and in the businesses and services to which it is allied, an acceleration caused by factors that are continuing and virile, and that, therefore, demands the engineer's adaptation thereto.

A second development of the last fifty years that impresses itself strongly on the publisher is the special nature of the contribution that the mechanical engineer has made to human welfare. The communists, the socialists, the professors of sociology in many colleges that should be feeding sounder thought to their students, rage about our present civilization and deplore our failure at once to bring the millennium. While they idealize and theorize, the ascent from Victorian industrial gloom has been steady and, during the past thirty years, very rapid. The engineer has gone steadily to work, winning the battles that the idealists dreamed but had not the ability to carry on and to win. Without any fuss, his work has changed unsanitary to sanitary factories, reduced industrial accidents and occupational diseases, brightened up shops, eased the load of physical labor, and, by raising wages and shortening hours, sent the worker out into the sunshine with money in his pocket to enjoy his leisure. Not credited with idealism is the engineer, yet he has made idealism real. Practical to the last degree, he has nevertheless erected a physical throne for spiritual man.

The engineer of every persuasion has made his contribution to this fine end: the mining and metallurgical engineer by his development of new metallurgical products and processes; the chemical engineer by his revolutionary discoveries; the electrical engineer by the improvement of the generation, distribution, and application of electrical energy; the civil engineer by his progress in sanitation and in structural work. But it remained for the mechanical engineer to make a dual contribution that affected in a special way the material progress of mankind; first, by his marvelous contribution in the devising of new, ingenious, high-capacity machinery, and, second, by his specialization in management. Let me lend emphasis to the latter development. The original apostles of scientific management were all members of this society; it was here that they made the reports that profoundly affected the profession, and electrified the public: Frederick W. Taylor, Henry L. Gantt, and Harrington Emerson, the latter, happily, still with us. Eagerly your members took up the work and have pursued it ever since. As a result I hazard the statement that no single agency in the world has done so much for human advancement in the last thirty years, no group has placed the world under so profound obligation to it for physical benefits, no body has affected so signally the welfare of the worker, as have the members of this society. The world may forget to consult the record and to give credit where credit is due, but there stands the record for all time, and none can gainsay it.

I know that the work of the engineer is decried. It is said that he is converting men into machines and that the physical civilization he has created is the cause of moral and spiritual decay. I know of no better time and place to meet these accusations than at this celebration and before this audience.

True, there are men today doing repetitive work. It is not inspiring. It does not encourage intellectual development. It may, to an extent, be deadening. But those who state the fact as an accusation assume that this is a new condition caused by the machine. As a matter of fact, anyone that has reached the high-school age can know from his reading that there have been hewers of wood and drawers of water in every age, and that that condition will probably continue for ages to come. He can know that these minds are incapable of much improvement; that these individuals cannot carry responsibility and are unhappy under it. He must know, too, if he honestly studies the problem, that never was the search so keen for men who can rise in any line of endeavor. Constantly we comb our forces for foremen, designers, toolmakers. There are better opportunities for those who can rise. At the same time, in America at least, conditions, wages, and leisure were never so advanced for those who do the unskilled tasks.

But the other charge is in some respects the more serious. We are told that our vast wealth creation has directed men's thoughts solely to material things and that there is, in consequence, a decline in morals and in our spiritual

life. Wealth holds in itself the seeds of decay, so runs the thesis. The thesis, I maintain, is false and cannot be successfully defended. If character be strong, the possession of wealth does not result in moral decay; wealth is then rightly evaluated as a means and is wisely employed. If character be absent, undoubtedly wealth will hasten decline and bring disaster. Further, our wealth creation affects the whole public and not merely a few individuals. We have our living on a decent standard, sufficiency instead of hunger, sanitary surroundings instead of squalor, general education instead of ignorance. These conditions, I hold, favor moral and spiritual development.

Far from deserving blame for his services in the acceleration of wealth creation, the engineer deserves the greatest praise, for, mark you, he has prepared an environment more favorable to moral and spiritual growth than was the poverty, squalor, disease that preceded it. If character development has not kept pace with wealth creation, it is the fault of the lay and religious teachers who most often bring the charge. Pray God that they may become equal to the task and rise to the high opportunity of favoring the environment that the engineer and his work have created. Their task has been made easier if they would but recognize the facts.

The engineer, of course, is first to admit that the task is not completed. There are still blots on our industrial system. There always will be, for as we advance, so will our ideas of the opportunities before us. Man's wants and desires are insatiable. Right now, for example, we appreciate with special keenness that it is a great reflection on our industrial and social systems that men who want work cannot find it. That we shall find remedies for cyclical, seasonal, and technological unemployment, and find them in our own way, without resorting to European models, I firmly believe. We solved the problem of accident compensation. So shall we solve unemployment and other problems in their turn.

Keeping Shaft Sets Aligned in Bad Ground

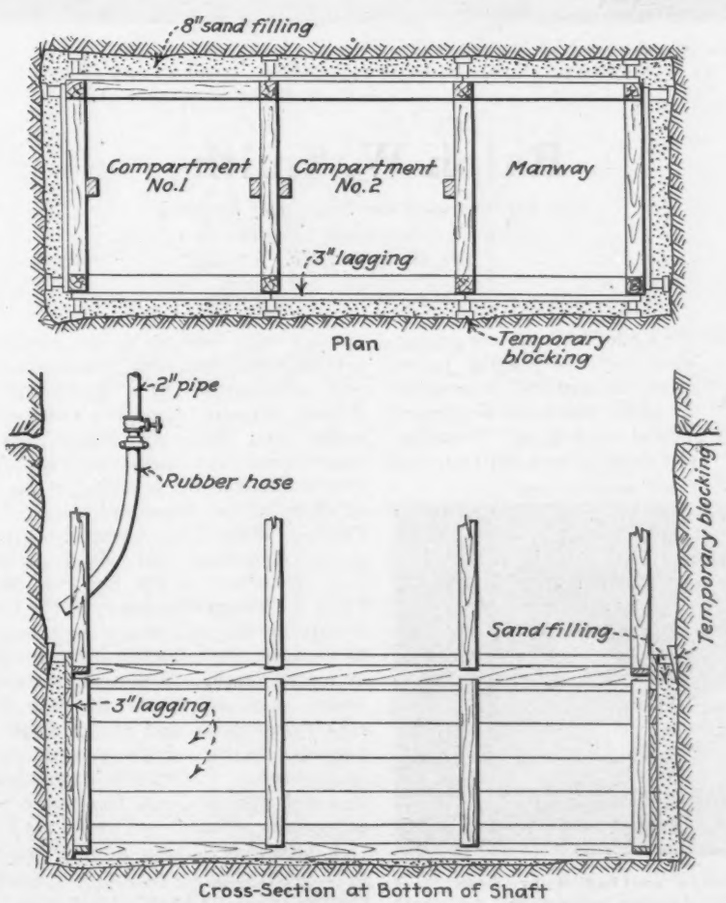
CAVE-INS and twisted shaft sets are difficulties that occur frequently in shafts sunk in swelling ground. The swelling generally is caused by the exposure of the rock to air and moisture. This is usually prevented by either employing continously a force of men to rectify and replace the shaft sets to keep the shaft open, which method involves a high maintenance cost throughout the year, or by sealing off the rock with concrete linings, which is also expensive.

In the Hecla shaft and the Star raise of the Hecla Mining Company, in Idaho, difficulties of the aforesaid character were encountered and remedied by a method developed and applied by Fred Johnson, superintendent, Chief Consolidated Mining Company, Eureka, Utah. A description of the method follows:

Instead of using concrete, the vacant space behind the lagging is filled with fine sand, which acts as a cushion and at the same time prevents moisture and air from coming in contact with the shaft walls. The first operation is to align all shaft sets and to replace all old lagging with new 3-in. boards, beginning at the bottom of the shaft. Care should be taken to keep the distance between the lagging and shaft walls at a minimum of 8 in. Each set is temporarily kept in line with wooden blocks and wedges, which are knocked out as the level of the sand rises. The only equipment necessary for the filling operation is a wooden trough, with a screen attached to the open end, placed on a slight angle, at the mouth of the shaft, and a 2-in. pipe line, to one end of which is fitted a sheet-iron hopper, installed in the shaft. Fine sand is shoveled by operators into the trough, and with an excess amount of water, is washed into the hopper and then conveyed to the bottom of the shaft, where an operator, with the aid of an attached rubber hose, evenly distributes the sand behind the lagging, as shown in accompanying sketch. The procedure is repeated, and the pipe column shortened as required, until the last set near the mouth of the shaft has been reached.

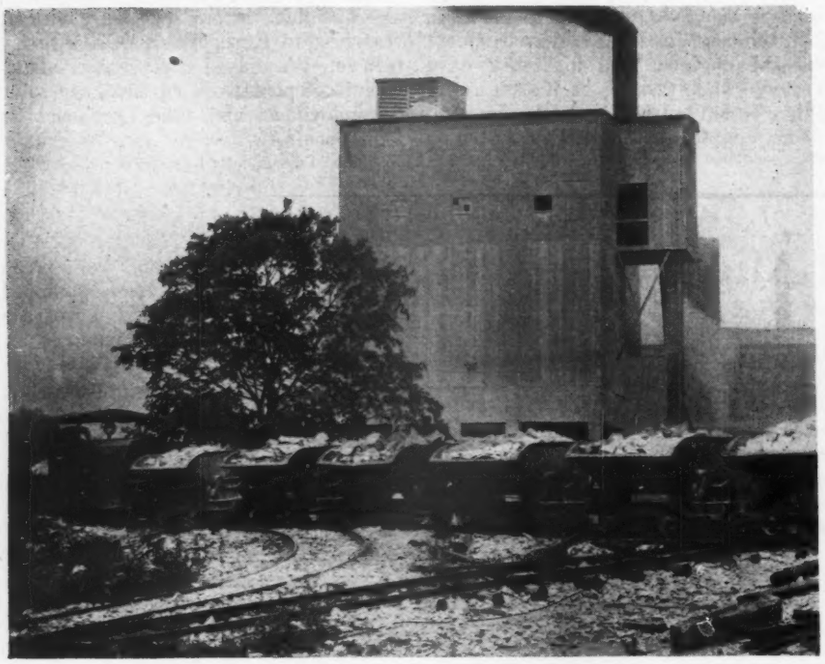
The water from the sand collects in the sump of the shaft and is pumped back to the surface through a centrifugal pump. Rapid wear of pump parts, caused by the fine sand particles contained in the water, will be experienced. The saving possible by the use of the method more than counterbalances this expense.

A careful inspection of the Hecla shaft and Star raise nine months after the application of this method disclosed a perfect alignment of the shaft sets and no increased pressure from the shaft walls.



Cross-Section at Bottom of Shaft

Mine Transport of Limestone

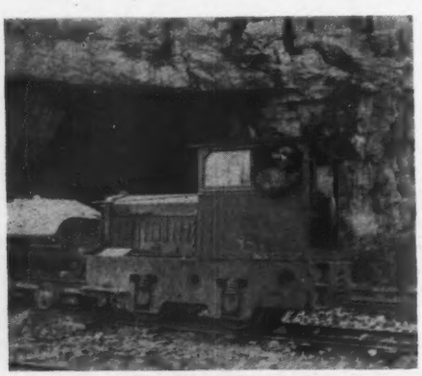


A train of rock cars from the mine

Ralph W. Smith

Mine Superintendent and Director of Research
Peerless White Lime Company,
Ste. Genevieve, Mo.

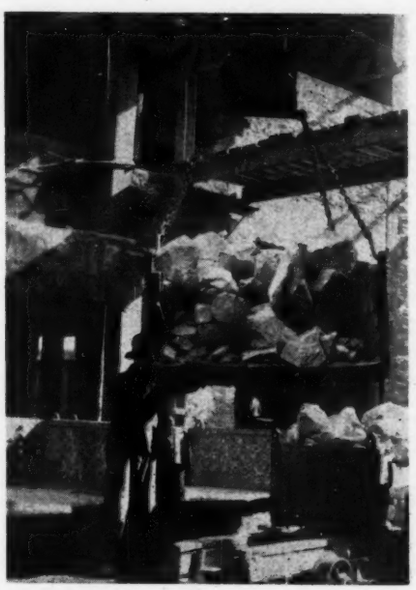
A SUBSTANTIAL part of production costs in mining operations is usually represented by items which can be grouped under a general heading of "Transportation," even though some difference of opinion may prevail as to where the dividing line between "Transportation" and "Refining" or "Treatment" is drawn, because the labor involved is under two different departments of supervision. An interesting example of this is found in the handling of the raw product at the limestone mine of the Peerless White Lime Company, situated at Ste. Genevieve, Mo., which company is a subsidiary of the Hunkins Willis Lime & Cement Company, of St. Louis. Whatever the differences may seem to be between the transportation problems of metal mines and those of limestone mines, such differences are to a great extent superficial and are probably intensified by the narrow margin in the lime industry that results in conditions in which operators are frequently what are known as "marginal producers."



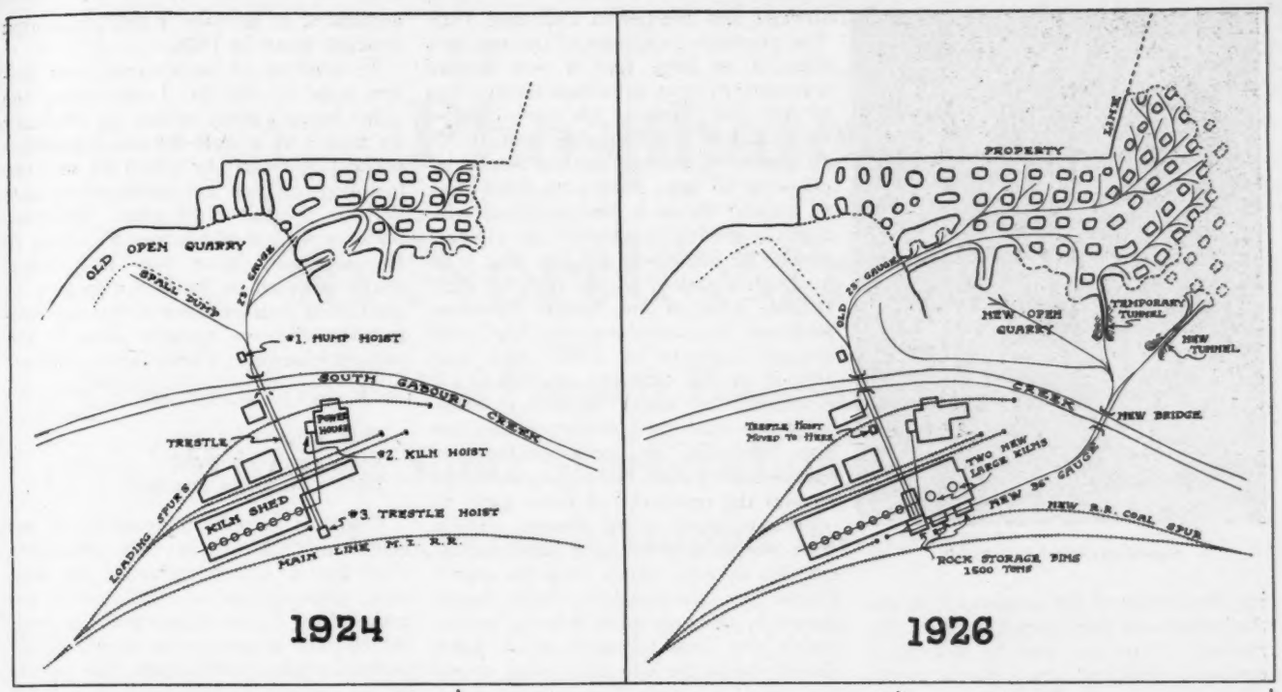
Trains are hauled by 8-ton gasoline locomotives

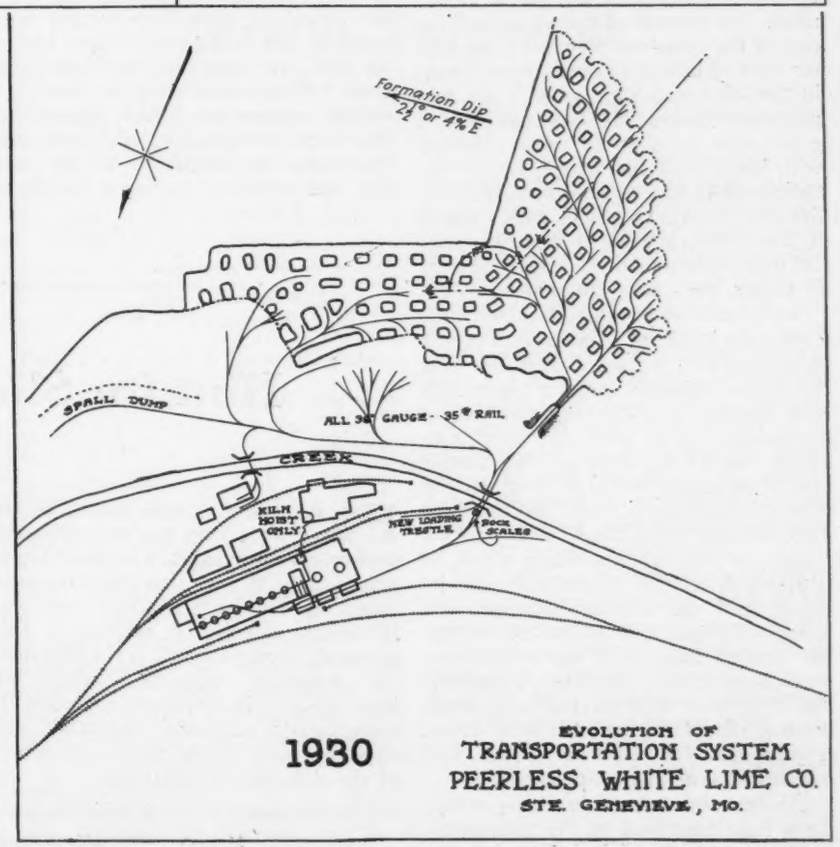
A limestone quarry usually becomes an underground operation by a gradual process of "reluctant transition," in spite of the many advantages of quarry operation. During this transition period numerous steps are taken by operators unfamiliar or unskilled in planning the resultant layout to function as an efficient unit, with flexibility, and economy, both for expansion and contraction of production. Considerable planning is necessary when changing such an operation to a more efficient unit that will yield maximum results and yet maintain production and low operating costs during the transition period. The advisability of revamping transportation at the Peerless mine was recognized about five years ago, and the improved efficiency resulting from remodeling this phase of operation has thoroughly justified the capital expenditure involved.

In 1924, rock was delivered to the top of the kilns, about 70 ft. above the mine floor, by a combination of gravity plane, mule haulage, and three steam hoists. Although the number of hoists seems excessive, each hoist was justified by certain peculiar local conditions. The first hoist pulled trainloads of rock from the mouth of the tunnel over a steep "hump," then across a bridge, and finally spotted the trainload at the foot of an incline about 150 ft. from the foot of the kilns; the second hoist took the cars up an inclined trestle which



Rock boxes being hoisted into the kilns





cleared the railroad shipping spurs; and the third picked the boxes from the trucks on the trestle and distributed the rock to the various kilns. Thus, each hoist seemed justified, but the scheme required an excessive transportation crew. Moreover, the gravity planes in the mine were so long that they were becoming dangerous, and minor accidents occurred because of inadequate braking equipment.

Other unsatisfactory features of the system were: a mixture of rail weights which ranged from 25 lb. to as heavy as 50 lb.; an odd-sized gage of 23 in.; various lengths of lead rails; various weights and lengths of switch points; numerous types of throws; and many different numbers, types, and weights of frogs. Another condition which needed correcting was shortage of storage capacity for kiln rock. The Peerless mine operates on a six-day week, and, inasmuch as the kilns operate continuously, rock storage facilities to take care of the period of shutdown in the mine must be available. Furthermore, a 36-hour rock storage capacity is a valuable safety factor in coping with a temporary and unexpected breakdown of equipment or a shortage of personnel. In addition to correcting these various undesirable features, any new transportation system had to combine efficiently with plans to expand the capacity of the plant; construction of two new large production kilns was begun in 1925.

The accompanying plant map for 1926 shows the primary stage of development at that time. Among the main changes are: Trestle hoist moved to foot of trestle to make room for concrete storage bin; temporary tunnel driven to nearest portion of mine workings to furnish rock supply for new kilns over wider gage track; new bridge across creek; new permanent mine entry started; replacement of quarry and mine track with new track of 36-in. gage; new open quarry started to supplement mine production; new railroad coal spur to new kilns.

By 1930 the process of transportation development had reached that shown in the map for that year. The notable features of the present layout as shown in that map are: Complete conversion to 36-in. gage; permanent entry to mine workings; kiln hoist moved close to rock bins, and only one hoist used, instead of three hoists, as formerly; new loading trestle for loading raw product into railroad cars placed in better position, eliminating extra hoist; more direct route of rock to storage bins for kilns.

As shown in the 1930 map, the center lines of the pillars are turned 45 deg. from the early center lines, after round-

Standard Peerless switch

ing the corner of the property line, and the pillars are also staggered in one direction. This was done to reduce excessive grades and sharp curves in the mine. On account of the dip toward the east of the limestone formation, the center lines of pillars and main mine tracks in the 1924 map were on a 4 per cent up-grade toward the headings, which grade was sufficient to cause difficulty with heavy loads on sharp curves. By turning at 45 deg. with the former center lines, the maximum grades were reduced to 2 per cent, and where the main lines cut diagonally across the staggered lines of pillars, the tracks are almost level.

The parallel duplication of mine tracks across the headings reduces track laying to a minimum, because each line is used for three different mining operations and remains in place until the rock is exhausted. The first line of tracks serves the 15 ft. headings; the second line, a secondary cut to a 20 ft. parting which makes a good roof; and the third line, the final cut to the 40 or 50 ft. roof. Thus, as fast as one main track is abandoned, another is ready to take its place, and the mining, loading, and track operations can proceed on a regular routine basis with no interference from each other. Moreover, a substantial supply of broken rock and ample loading tracks are available at all times. Furthermore, development is kept well ahead of the main rock reserve.

Among the intangible items which have been improved in the transportation system and which do not show on the map are: Complete standardization of all track supplies; 35 lb. rail throughout; No. 4 plate riveted frogs, 42 in. long; 6 ft. switch points; standard ground throw switches, except where spring switches are used; 12 ft. lead rails; rail braces on heavy-duty curves; Koppel all-steel standard low-type 2x36-ft. rocker cars; three Whitcomb 8-ton gasoline locomotives.

Another important part of the transportation equipment is the concrete rock storage bins erected in 1926 and 1927. The productive capacity of the two new kilns is so large that it was deemed necessary to erect individual storage bins of 200 tons' capacity for each kiln, so as to assure an ample rock supply for 36 hours. These bins have a bottom inclined at 45 deg., lined with sheet iron, to prevent abrasion, and equipped with a quick-opening compressed-air arc gate and chute for filling a 5-ton skip. To provide storage for the line of eight smaller kilns, a flat bottom two-compartment reinforced-concrete bin, with storage capacity of 1,100 tons, was erected in line with the other bins. It is tapped by eight steel-lined holes, emptying into steel chutes, which are also controlled by quick-opening air-operated arc gates. An ingenious device enables the operators of these gates to open any gate or to change quickly from one to another; and only one air cylinder is used. Rock from the chutes dumps into transferable wooden boxes placed in pairs on roller-bearing trucks, which are hand-trammed to a point directly below the kiln hoist cable, where the boxes are picked up by the hoist engineer and transferred to any kiln in the line. A further storage capacity of about 180 tons is secured by loading all rolling equipment before shutdowns. The rock storage afforded by the bins also makes it possible to fill the kilns day and night, a necessary factor on account of an increase in kiln production brought about in 1928.

In addition to an accurate cost system kept by the St. Louis office, the plant keeps a close watch on efficiency by means of a staff-devised labor-hour production record, by which the tons per man-hour of labor are calculated on each division of labor in the mine. The comparative figures of tons per man-hour of transportation labor for the various years indicated on the plan map give an interesting measurement of the improvement in efficiency brought about by the various changes. These figures follow:

	Tons per Man-Hour
1924, original system	3.5
1926, partly changed	4.6
1929, completely changed	5.7

Thus, an extreme increase of 63 per cent was attained in time efficiency. This has a strong influence on final costs, although not to a full extent, because of the higher wages paid for more skilled labor in part of the present transportation crew. However, the results show considerable improvement in a cost comparison, and this is the basis of the statement made in an earlier part of this discussion, to the effect that "the improved efficiency resulting from remodeling this phase of operation has thoroughly justified the capital expenditure."

Hint for Slide-Rule Users

EVERY engineer who has much use for a slide rule has evolved some method for keeping track of the decimal points, only to find that the system is likely to fail at a critical juncture. William J. Alcott, Jr., writing in *Engineering News-Record,* gives a system of "one-place" logarithms which he says not only fixes the decimal point in complicated calculations but also provides a rough check on the accuracy of the slide-rule computation.

The mantissas given are as follows:

Number	Memory Mantissa	Two-Place Mantissa
1.3	0.1	0.11
1.6	0.2	0.20
2	0.3	0.30
3	0.5	0.48
4	0.6	0.60
5	0.7	0.70
6	0.8	0.78
7	0.85	0.85
8	0.9	0.90
9	0.95	0.95
10	1.0	1.00

A brief glance at a log table will convince the reader of their accuracy. For use, the "memory mantissas" should be memorized according to the following scheme: The mantissas 0.1 and 0.2 correspond to the numbers 1.3 and 1.6 which are spaced approximately evenly between the numbers 1 and 2. The mantissa for 2 is 0.3. Then for numbers 3 through 6, the mantissas are two more than the number—that is, for 3, 0.5; for 4, 0.6; for 5, 0.7; and for 6, 0.8. Then for the numbers 7 through 9, the mantissas increase by steps of half-tenths; thus the mantissa for 7 is 0.85; for 8 is 0.90 and for 9 is 0.95.

The column of mantissas for two places is added for comparison, although for purposes of rough check and pointing off, it is not necessary to memorize its variations from the single-place figures.

"One-place" logarithms are used just as ordinary log tables are used. That is, when each is assigned its proper characteristic, it may be added or subtracted, multiplied or divided. The result will give the number of decimal places accurately, while the slide rule is used to obtain the significant figures.

Phosphate in North Africa

Production From French Possessions Gradually Winning Some Markets Long Supplied by American Mining Companies

Eric B. Townsend

THE ever-growing importance of the North African phosphate industry as one of the greatest industrial developments is now widely recognized. Yearly increases in exports have materially affected the growth of the industry in the United States. France holds the key to North African mines. Formerly, that country was one of the greatest buyers of American phosphates. Today it is an exporter. Last year America imported 16,496 metric tons of this commodity from French possessions.

According to recent estimates, the world production of phosphate amounts to roughly 10,000,000 metric tons per annum, of which quantity France, together with her North African mines, produces half, America a third, and all other sources a sixth.

The estimates in Table I are based on calculated production figures for 1928 and show approximately the mineral phosphate output of the principal producers.

Table I—Phosphate Output of Principal Producers

Country	Amounts in Metric Tons
Tunisia	3,000,000
Morocco	1,200,000
Algeria	1,000,000
France	200,000
America	3,300,000
MaKamea, Nauru, and other minor producers	700,000
Pacific Isles	200,000

As crude phosphates can be used for fertilizing purposes only under unusual conditions (on very acid soil),[1] they are treated with sulphuric acid to obtain what is known commercially as superphosphates, which are soluble in water and readily absorbed by plants. The total annual world production of superphosphates from all sources is estimated to be about 14,250,000 metric tons, of which Europe manufactures 61 per cent, America 23, Australia 8, Asia 6, and Africa 2.

Table II gives the production of superphosphate in Europe for 1928:

Table II—Output of Superphosphate in Europe, 1928

Country	Amounts in Metric Tons
France	2,000,000
Italy	1,500,000
Spain	1,000,000
England and Germany	800,000
Holland	600,000
Central European States	500,000
Denmark	250,000
Sweden	230,000

The remarkable development of the North African phosphate mines has seriously affected the growth of the American phosphate industry during recent years. More particularly, the crude Moroccan phosphate rock, which is equal in quality to the best produced by the Florida mines, has made rapid strides in acquiring prestige with all the larger European markets. The entire rights for the exploitation of these Moroccan deposits were reserved, by decree of Jan. 27, 1920, for the French Protectorate, which created for the control of this industry the Office Chérifien des Phosphates. This organization began with a capital of 36,000,000 francs, furnished by a special loan made from the budget of the Protectorate (the French law of Aug. 19, 1920). This office is administered like a private corporation, by a general director, controlled by a board of administrators, and is not exempt from the laws and taxes to which any private business is subjected.

Since 1920 the Office Chérifien des Phosphates has exploited very important calcium phosphate deposits occurring beneath the plain which joins Ouled Abdoun to Oued Zem and Ben Ahmed. The center of the mines is at Kourigha, situated at about 140 km. from the port of Casablanca, Morocco's most important harbor. These deposits consist of almost horizontal beds of late Cretaceous or early Eocene periods. The upper stratum is about 1.80 m. in thickness and lies at about 30 m. below the surface of the plain. At certain points, however, it is exposed to view where the land has undergone erosion or is cut through by ravines.

The methods of mining these phosphates are similar to those used in the Algerian and Tunisian deposits. The rock is picked out by hand, loaded onto small hand-pushed trucks, carried to the secondary depots, transferred to the main train, and hauled to Casablanca by electrically driven locomotives. At Casablanca, the phosphate rock is then either put into storage or loaded directly

Annual exports of Moroccan phosphates are given in Table III:

Table III—Exports of Moroccan Phosphate Compared with United States Production

Year	Morocco Metric Tons	United States Long Tons
1920	.....	4,104,000
1921	8,232	2,064,000
1922	79,815	2,418,000
1923	190,723	3,007,000
1924	430,441	2,867,000
1925	721,228	3,482,000
1926	885,720	3,210,000
1927	1,198,006	3,170,000
1928	1,337,079	3,501,000
1929	1,608,249	.....

(1) This view long prevailed. Competent opinion today holds that raw phosphate, finely ground, can be applied directly to the soil in many cases. Nevertheless, the bulk of the crude output is first converted into readily soluble form by treatment with sulphuric acid.—EDITOR.

on transports, by means of mechanical loaders.

The high content of calcium phosphate found in crude Moroccan phosphate rock (75 per cent tricalcium phosphate with less than 1 per cent aluminum and iron) makes this rock very suitable for the purpose of manufacturing high-grade superphosphate. Accordingly, in 1925, there was established at Casablanca a company called the Compagnie des Superphosphates et Produits Chimiques du Maroc, a subsidiary of the Etablissements Kuhlmann. Since 1925, this company has increased its output of superphosphates from 15,000 metric tons to a little over 25,000 metric tons. Recently announcement has been made that the capacity of this plant will be increased to 50,000 metric tons per annum. The greatest part of this company's product is now consumed in Morocco, where it is sold at a price about 30 per cent below the current market price for imported phosphates.

During 1929, the Office Chérifien des Phosphates made the exports given in Table IV:

Table IV—Exports of Phosphate by Office Chérifien des Phosphates

Country	Amount in Metric Ton
France	248,052
Germany	123,881
Czechoslovakia	43,921
Hungary	60,489
Denmark	111,215
Norway	13,423
Poland	8,980
Balkan countries	25,860
Spain	288,510
Holland	140,352
Italy	138,477
Belgium	19,608
England	59,759
Portugal	11,336
Switzerland	5,084
Yugoslavia	8,710
Roumania	5,724
Russia	55,053
Sweden	12,089
Australia	91,070
Cuba	4,959
U. S. A.	16,496
South Africa	58,249
Japan	39,912
Other countries	4,724
Total	1,608,249

A glance at Table V shows that Moroccan phosphates have made enormous gains in exports to France, Germany, Spain, and Italy:

Table V—Exports of Moroccan Phosphate to France, Germany, Spain, and Italy

	1,000 Metric Tons			
Country	1929	1928	1927	1926
France	248	201	209	175
Germany	123	87	120	74
Spain	288	243	221	174
Holland	140	163	170	150
Denmark	111	99	97	60
Italy	136	63	105	68
England	59	47	41	40

Table VI—Production and Profits of Cie. des Superphosphates et Produits Chimiques du Maroc

Year	Amount in Metric Tons	Profits in Francs
1925	15,000	338,634
1926	23,866	1,300,000
1927	25,188	1,052,165
1928	25,000 (about)	1,022,294

Table VII—Production of Tunisian Phosphate, 1928

Company	Production in Metric Tons
Gafsa (Cie. des Phosphates et du Chemin de Fer de Gafsa)	1,958,000
Tunisienne (Cie. Phosphates Tunisiens et Engrais et Produits Chimiques)	336,000
M'Dilla	332,000
Dyr	77,000
St. Gobain	62,000
Bir Lafau	24,000
Total	2,789,000

The Compagnie des Superphosphates et Produits Chimiques du Maroc has a capital of 8,000,000 francs. Table VI gives the amount of superphosphates manufactured and the net profits made.

Tunisia is also an important source for French phosphates, but, in contrast with the Moroccan deposits, exploitation is carried on by numerous individual companies. Phosphates, moreover, coming from these deposits are in general of lower grade. Statistics for the production of Tunisian phosphates during 1928 give the relative order of importance of these several companies as shown in Table VII.

Of the companies mentioned in Table VII the first two only are considered important: the Cie. Gafsa because it is the largest and the Cie. Tunisiens because it is a subsidiary of the French company, Saint Gobain. Table VIII gives annual exports of phosphates made by these two companies.

Table VIII—Annual Exports by Gafsa and Tunisiens Companies

Year	Cie. Gafsa	Cie. Tunisiens
1922	1,496,342	17,255
1923	1,538,767	21,414
1924	1,715,958	142,909
1925	1,829,582	263,724
1926	1,880,533	275,078
1927	2,039,572	314,338
1928	1,885,732	330,687
1929	2,043,350	424,815

In 1912, a plant for the manufacture of superphosphates was established at El Afrane, near Tunis, called the Société Algerienne des Produits et d'Engrais Chimiques. The production of this superphosphate plant for the year 1927 was 42,672 metric tons and in 1929, 44,000 tons.

Although exports of phosphates have increased during the last year, production and supplies on hand have diminished. This is said to be due to the competition from the Moroccan deposits, and to the fact that mineral now mined in Tunisia has decreased in quality and has become more expensive to work.

Table IX—Output and Exports of Tunisian Phosphate

	1929	1928
Production of Tunisian phosphates	2,511,000	2,789,000
Exportation of Tunisian phosphates	3,018,000	2,684,000

Exploitation of the Algerian phosphate deposits is smaller than that of either Tunisia or Morocco. The main company established in Algeria is called the Compagnie des Phosphates de Constantine, which exploits mines situated at Djebel-Kouif. This company has a capital of 45,000,000 francs. Exports made by the Compagnie Constantine were 766,926 metric tons in 1929, compared with 709,687 metric tons in 1928. Production of Algerian phosphates, furnished by Bordj-Redir, M'Zaita, and Djebel-Kouif deposits, was 817,074 in 1928 and 919,108 in 1927.

Beatrice tin mine at Epoch, Federated Malay States

Zinc in the Southwest

Oliver C. Ralston

Director of Research,
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Jerome, Ariz.

ARIZONA has never been an important producer of zinc ores, for several reasons. Most of the zinc ores in the state are complex sulphides, frequently difficult to separate. Most of the deposits have been of small or moderate size. The grades of concentrate which could be prepared have usually been such that, combined with long freight haul to the smelting centers, their preparation was unprofitable. The Chloride district, in Mohave County, in the northwestern corner of the state, has been one of the few consistent shipping districts.

THE introduction of flotation and electrolytic treatment of zinc flotation concentrate has made necessary the recalculation of the value of prospects formerly considered of little or no value. The flotation treatment is applicable immediately, but electrolytic treatment must await the development of hydroelectric power.

If and when the Colorado River power controversy is settled and the power developed, almost certainly one or more electrolytic zinc plants will be constructed. The zinc-bearing areas occupy a band from the northwest corner of the state, at Chloride, to the southeast corner, at Bisbee. These areas will doubtless come under development at that time.

AT PRESENT the Jerome district is the only one containing a known large tonnage of zinc ore. Likewise, it has remained largely undeveloped or ignored until the last few years. Zinc was known in the United Verde ores for many years, but only recently has any systematic attempt been made to estimate how much of it is available. The United Verde main deposit is a huge pyritiferous mass, in the shape of a crescent-shaped chimney set at an angle. Much of this chimney consists of massive sulphides. Disseminated ore occurs along one edge to a certain extent and is being concentrated by flotation. Copper and zinc minerals occur in variable proportions throughout the mass. Where the copper content is high enough, the material is called copper ore and is smelted direct. Where the zinc content is high enough, the material will be called zinc ore. At present 7 per cent zinc is tentatively taken as the amount which shall be called ore. At some points, both high copper and high zinc analyses occur, but this "overlap" is rather small in proportion to the total. None of the deposit is free of zinc or free of copper. The orebody has been penetrated to a depth of 3,000 ft. and a new shaft, to go to 5,000 ft., is now being sunk. Development is not complete, even in the higher levels, and therefore total tonnages available are unknown. Apparently, there will be a greater tonnage of zinc ore than of copper ore.

FLOTATION research on these ores has been difficult. First, the crystal size of the component minerals is extremely fine. To obtain 90 per cent liberation of the zinc minerals, grinding through 800 mesh is required. This is impractical, so considerable proportions of middling products must be made if the grind is 200 or 300 mesh—the present commercial limit. Grinding to this size makes possible a high extraction of the zinc in a rougher concentrate, but this must be further ground prior to cleaning before it can be graded up in a satisfactory manner. If 55 per cent zinc concentrate is made, the net extraction of zinc is about 80 per cent. By dropping the grade to 45 per cent, the zinc extraction can be raised to 90 per cent. Part of the zinc is in the copper concentrate, which is made simultaneously. Pyrite is the main contaminating mineral in this concentrate. The zinc itself is present as marmatite of uncertain analysis. The only crystals of the marmatite which were of sufficient size and purity to analyze showed it to be a marmatite with about 10 per cent iron sulphide and 60 per cent zinc. It is black, except in thin sections. A flotation concentrate containing 55 per cent zinc will also carry 1 to 2 per cent copper, 3 to 20 oz. of silver per ton, and 0.02 to 0.05 oz. of gold. The copper concentrate produced will contain 10 to 15 per cent copper and 5 to 10 per cent zinc; the silver and gold content will be higher than in the zinc concentrate.

THE flotation work advanced through microscopic laboratory until the necessary grind was determined, then into small laboratory testing machines, then into a test mill with a capacity of 200 to 500 lb. per hour. The test mill started operation in February, 1929, and is now nearly through with its work. At present, the first unit of the concentrator for treatment of zinc ore is under construction, and it is to go into commission during the summer. It is rated at 300 tons daily, but will probably treat more. It is regarded as a semi-commercial or pilot unit in which final details of treatment will be worked out.

Ore which responds to treatment is made up mainly of pyrite, marmatite, and chalcopyrite, with schistose gangue. From such ore, selective flotation of the pyrite, first, and the marmatite, second, is possible by proper reagents. Something in the Jerome ores causes serious over-frothing in flotation machines unless collecting reagents are used that are strong flocculators of the floatable minerals. It was in the Clarkdale concentrator that one of the early applications of potassium amyl xanthate was made, owing to its ability to give this desirable result, and it is at Clarkdale that mixtures of the amyl (which causes over-flocculation or under-frothing) with the ordinary ethyl xanthate (which causes under-flocculation or over-frothing) are used in such proportions as to control the working quality of the froth.

ORES from the upper levels, where surface alteration has caused copper to concentrate as chalcocite, bornite, covellite, and similar enrichment zone minerals, cannot be treated successfully by selective flotation, because the marmatite floats directly with the copper minerals and cannot be successfully dropped. These ores have, at some time in their history, been in contact with copper sulphate solutions, and hence their marmatite contents are already activated toward flotation, whereas the unaltered deeper ores require addition of copper sulphate to the mill pulp before the zinc mineral is activated. Deactivation of the upper-level ores by treatment with solvents for cuprous and cupric sulphides is only partly successful. Merely adding chalcocite to an otherwise unactivated pulp will cause flotation of the marmatite—pointing toward the probability that chalcocite has a low but effective solubility in the water of the pulp.

Metallurgical treatment of the copper and zinc concentrates is not at present completely worked out. The copper smelter at Clarkdale can undoubtedly treat the copper concentrate, inasmuch as the concentrate from the present disseminated schist ore contains 4 to 10 per cent zinc, which is at present wasted. However, means of recovery of the zinc from the matte and slag of the copper-smelting operation is now well along in development. For the zinc concentrate, with its copper and precious metals, electrolytic treatment is contemplated, the residues to be sent to the copper smelter. Research on electrolytic treatment was begun only in the past year. A plant capable of making a minimum of 200 lb. of cathodes per day is under construction.

This is an abstract of a paper that was recently presented at the annual meeting of the American Zinc Institute, at St. Louis, Mo.

Digest of Current Technical Literature

Selected from abstracts of articles in the leading technical periodicals, prepared by Engineering Index Service, American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

Limestone Quarries and Quarrying: France—Stone and Mineral Earths. J. Prouteau. *Revue des Matériaux de Construction et de Travaux Publics,* No. 241, Oct., 1929.

DETAILS of design and equipment of plant at Comblanchien, France. (Concluded.)—E.I.S., New York.

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Powder: Moisture Absorption—An Apparatus for Tracing the Change in Moisture Content of Small Quantities of Powder. L. H. Lampitt and J. H. Bushill, *Jl. of Sci. Instruments,* Vol. 6, No. 12, Dec., 1929.

METHOD of tracing change in weight of small quantities of powder (0.02-0.2g.) due to absorption or loss of moisture in atmosphere of known humidity; principle depends upon observing by means of traveling microscope rise or fall of arm of delicate torsion balance.—E.I.S., New York.

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Mines and Mining: Air Compressors, Portable — Portable Compressors Proves Its Value in Prospecting Work. J. N. Herring. *Compressed Air Mag.,* Vol. 35, No. 2, Feb., 1930.

NOTES on development practice at lead-zinc mines in Montauban, township about 5 miles from Notre Dame des Anges station in Canadian National Railway; use of 10 by 8 in., Type 20, portable compressor on skids, Utility hoist, drill sharpener, and two Jackhamer drills; performance data and costs are given.—E.I.S., New York.

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Gold Ore Treatment: Canada — Gold Milling in Canada. J. J. Denny. *Can. Min. and Met.—Bul.,* No. 213, Jan., 1930.

PURPOSE of paper is to present brief outline of Canadian practice in milling of gold-bearing ores, not, however, including those auriferous ores which are mined and milled primarily for their content of some other metal; tabular gold production statistics; mill structure; crushing; classification; concentration; chlorination; flow sheets are given. Advance publication for mtg. Mar., 1930.—E.I.S., New York.

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Copper Smelting Plants: Quebec—The Noranda Smelter. W. B. Boggs and J. N. Anderson. *Can. Min. and Met.—Bul.,* No. 215, March, 1930.

SMELTER is located in western Quebec about 330 miles north of Toronto; designed by A. E. Wheeler; construction began Nov., 1925, and first blister copper was made Dec. 17, 1926; plant and operations are described by smelter superintendent and technical assistant; flow sheets of crushing plants and sampling mill are also given. —E.I.S., New York.

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Gold Ore Treatment—Testing Ores for Recovery of Gold Content. O. D. Welsch. *Canadian Mining Journal* (Gardenvale, Que.), Vol. 51, No. 3, Jan. 17, 1930.

DISCUSSION of laboratory investigations to determine process or combination or processes to which ore sample submitted will lend itself most profitably; processes most generally used for recovery of gold are amalgamation, cyanidation by agitation or by percolation, gravity concentration, and concentration by flotation.—E.I.S., New York.

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Gypsum—Varieties of Gypsum (Die Wasserbindungsstufen des Gipses). K. A. Goslich. *Tonindustrie-Zeitung* (Berlin), Vol. 53, No. 80, Oct. 7, 1929.

RAW GYPSUM (double hydrate) with two molecules of water, plaster of paris with $\frac{1}{2}$ molecule and anhydrite with no water of hydration constitute known varieties; anhydrite may be water-soluble or insoluble; temperature of 262 deg. F. is usual one for burning of crude gypsum to plaster of paris.—E.I.S., New York.

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Geophysical Exploration, Gravitational —A Gravitational Survey over the Pentland Fault near Portobello, Midlothian, Scotland. W. F. P. McLintock and J. Phemister. *Geol. Survey of Great Britain,* Part 2, 1929.

FULL TEXT of paper previously indexed, jointly with paper on Buried Kelvin Valley, from abstract in *Iron and Coal Trades Rev.,* Dec. 27, 1929.—E.I.S., New York.

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Mines and Mining: Equipment Lining—Wear-Resisting Linings. H. Reiser. *Glueckauf,* Vol. 65, No. 47, Nov. 23, 1929.

ATTENTION is drawn to merits of fused basalt as substitute for steel, cast iron and ceramic material in applications where special resistance to wear and abrasion is required in pipes, troughs, tanks, etc., containing abrasive material; in many instances saving on direct and indirect cost of renewal, where basalt is used, is more important than actual saving in cost of material.—E.I.S., New York.

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Antimony Mines and Mining: China—Report on the Pan-Hsi Antimony Mine, Yi-Yang, Hunan. C. C. Tien, S. Y. Yuo and H. C. Wang. *Far Eastern Rev.,* Vol. 25, No. 9, Sept., 1929.

ONE OF the most important antimony mines in Hunan, situated 48 miles southwest of city of Yi-Yang Hsien; topography and geology; ore deposit; mining; smelting; mechanical equipment; transportation; tabular data on production and operating expenses.—E.I.S., New York.

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Fuller's Earth—Hightly Active Fuller's Earth. A. Scholz. *Chemiker-Zeitung,* Vol. 53, No. 93, Nov. 20, 1929.

CLAY from Southern Bavaria is made into thin suspension with water and this is pumped into a large boiler where it is digested with hot hydrochloric or sulphuric acid, dried and ground; the product is suitable for decolorizing oils of all kinds and 40,000 tons are used for this purpose in Germany annually.—E.I.S., New York.

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Copper Mines and Mining: Arizona — Recent Changes in Mining Methods at Ray Mines of the Nevada Consolidated Copper Co. C. A. Kumke. *Min. Congress Jl.,* Vol. 16, No. 2, Feb., 1930.

EFFICIENCY of men, elimination of timber repairs and improved ore extraction achieved; pyramidal undercutting system devised; uniform ore drawing essential; one hundred per cent extraction maintained; graphic illustrations and costs; discussion covering two stoping methods is reprinted in part from U. S. Bureau of Mines—Information Cir. No. 6167, indexed in Engineering Index, 1929.—E.I.S., New York.

•

Copper Smelting: Spain—Notes on Converting Low-Grade Matter at Rio Tinto and Present-Day Smelting Practice at Rio Tinto. H. R. Potts. *Instn. Min. and Met.—Bul.,* No. 305, Feb., 1930.

AUTHOR'S reply to discussion of paper indexed in Engineering Index, 1929, from Oct., 1929, issue of same journal.—E.I.S., New York.

•

Ore Treatment: Flotation — Flotation and Electric Charge of Precipitates. D. Talmud and N. M. Lubman. *Kolloid-Zeit,* Vol. 50, No. 2, Feb., 1930.

REPORT on experimental studies, made at Ore Treatment Laboratory of Moscow Institute of Applied Mineralogy and Metallurgy, of precipitation of solutions of silver iodide, calcium carbonate, and barium sulphate.—E.I.S., New York.

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Mines and Mining: Pumps—Centrifugal Pumps for Mine Service. C. H. S. Tupholme. *Mech. World,* Vol. 87, No. 2247, Jan. 24, 1930.

ADVANTAGES offered by centrifugal pumps of high lifting capacity in dewatering and shaft sinking; details of Pulsometer turbine centrifugal sinking pump, Conqueror high-lift turbine pump, and Sulzer sinking pump.—E.I.S., New York.

•

Feldspar Mines and Mining: North Carolina — Feldspar Development in North Carolina. B. C. Burgess. *Glass Industry,* Vol. 14, No. 3, Mar., 1930.

HISTORY of early development in modernizing industry; work of Feldspar Grinders' Institute; early mining efforts and research of Tennessee Mineral Products Company. —E.I.S., New York.

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Feldspar Mines and Mining: North Carolina—Feldspar Mining in North Carolina. R. C. Moore. *Ceramic Age,* Vol. 15, No. 2, Feb., 1930.

PROGRESS made in control methods in feldspar mining field in North Carolina; brief listing of many new grinding plants; brief account of method of production.—E.I.S., New York.

•

Tin Deposits: Bolivia—Tin Placers in Bolivia. *Ingenieria Internacional,* Vol. 18, No. 1, Jan., 1930.

BRIEF notes on alluvial and eluvial deposits, importance of which has been obscured somewhat by attention paid to working of vein mines; most favorable region is stated to be in southwest part of republic, between Lake Titicaca on north and Chocaya and Chorolque on south; some deposits are rich and also contain gold.—E.I.S., New York.

Mining Geology: Germany—Lode Displacements and Lode Correlations in Western Upper Harz. A. Stahl. *Zeit. fuer des Berg, Huetten- und Salinenwesen,* Vol. 77, No. 3, 1929.

LODE displacements and faults in mining districts are investigated and discussed.—E.I.S., New York.

•

Rock Drilling: Spitzbergen — Deep Drilling at Spitzbergen (Dyboring paa Spitzbergen). A. Orvin. *Teknisk Ukeblad,* Vol. 77, No. 1, Jan. 2, 1930.

DESCRIPTION of drilling in frozen earth and stone; total of 422.4 m. was drilled; deepest hole was 146.7 m.; drills were 5.25 to 3.25 in. in diameter.—E.I.S., New York.

•

Ore Treatment: Flotation — Modern Theories and Investigations of Flotation. S. Mortsell. *Teknisk Tidskrift,* Vol. 60, No. 6, Feb. 8, 1930.

DISCUSSION of froth builders and different reagents; list of nitrates having harmful influence on some minerals; determination of pH concentration and its importance.—E.I.S., New York.

•

Copper Ore Treatment: Quebec — Twelve Months' Milling at Noranda. C. G. McLachlan. *Can. Min. and Met.—Bul.,* No. 214, Feb., 1930.

OUTLINE of operations at concentrator treating massive sulphide ore carrying copper and gold, and sometimes zinc; climatic difficulties; lack of flotation operators; tailings disposal; characteristics of ore; flow sheet; operating data; sampling and assaying practice; concentration of this ore by flotation is feasible, but is complex problem.—E.I.S., New York.

•

Copper Mining Geology: Silesia — Genesis of Copper Deposits in Upper Permian Rocks of Lower Silesia. H. Scupin. *Zeit. fuer Praktische Geologie,* Vol. 38, No. 1, Jan., 1930.

GENESIS of copper deposits is discussed; epigenetic influence; syngenetic origin; influence of tectonic movements on formation of melaphre. Bibliography.—E.I.S., New York.

•

Zinc Metallurgy: Italy — Zinc Metallurgy in Italy. F. Sartori. *Metallurgia Italiana,* Vol. 21, Nos. 11 and 12, Nov. and Dec., 1929.

HISTORY of zinc industry of Italy; total Italian production at present is slightly in excess of consumption; engineering and economic features of Italian zinc industry; descriptive notes on four principal zinc producing plants of Italy. (To be continued.)—E.I.S., New York.

•

Ore Treatment: Concentrators — The James Ore Concentration Table. C. Berthelot. *Génie Civil,* Vol. 96, No. 7, Feb. 15, 1930.

DESCRIPTION, method of operation and specifications of James, Wilfley concentration tables; data on operating experience in treatment of tin and lead ores.—E.I.S., New York.

•

Zinc Ore Roasting: Equipment Corrosion—The Corrosion of Rabbles in Zinc Concentrate Roasting Furnaces. N. Greenwood and A. J. Roennfeldt. *Australasian Inst. of Min. and Met.—Proc.,* No. 75.

DESCRIPTION of experimental work on Barrier roasting furnaces at Port Pirie, South Australia; it was found that, as structural material for rabbles, alloys high in chromium, but containing no nickel, are superior to chrome-nickel, as corrosion is much less under operating conditions at that plant; tabular analysis of alloy and data on corrosion tests. Full text of paper indexed in Engineering Index, 1929, from abstract in *Eng. and Min. Jl.,* Nov. 30, 1929.—E.I.S., New York.

•

Potash Plants: Grinding Mills—Modern Grinding Equipment in Potash Plants. *Kruppsche Monatshefte,* Vol. 10, Nov., 1929.

NEW equipment at Hallersleben mine of Consolidierten Alkaliwerke, Westeregeln, with output of 120 tons per hour of 20 to 25 mm. grain size; 160 tons per hour have been produced with 6-mm. grain size; equipment described was supplied by Krupp-Grusonwerke.—E.I.S., New York.

•

Zinc Ore Treatment, Electrolytic—Development of Zinc Electrolysis. G. Eger. *Zeit. des Oberschlesischen Berg- u. Huettenmaennischen Vereins zu Katowice,* Vol. 68, No. 11, Nov., 1929.

HISTORICAL review and description of experiments, present practice; chloride and zinc-sulphate electrolysis; latest development of zinc-sulphate electrolysis; description of Tainton's process.—E.I.S., New York.

•

Radium—Possibilities of Production of Radium and Vanadium from Carnotite. H. A. Doerner. *Indus. and Eng. Chem.,* Vol. 22, No. 2, Feb., 1930.

VANADIUM from carnotite and related ores; distribution and variation of production costs; production from low-grade ores; concentration methods; extraction of radium from concentrates; extraction with acids; preliminary roasting; chemical dissolution of silica; volatilization of silica; recovery of vanadium and uranium.—E.I.S., New York.

•

Ore Crushing and Grinding — Stage Tube-Milling and Selective Grinding at West Springs. J. L. Willey and S. E. T. Ewing. *Chem., Met. and Min. Soc. of S. Africa—Jl.,* Vol. 30, No. 4, Oct., 1929.

PAPER supplements earlier work by same authors, as indexed in Engineering Index, 1925, p. 539, descriptive of experimental work on gold ores at West Springs plant on Far East Rand; summary and tabular comparative data on results of tests; outcome of application of stage methods and selective grinding was: increased milling capacity at lower cost, and increased recovery per ton of ore treated.—E.I.S., New York.

Mines and Mining: Cementing — Cementation Applied to Mining. F. G. Atherton. *Colliery Guardian,* Vol. 140, No. 3606, Feb. 7. 1930.

GENERAL review of cementation and silicatization processes; silicatization is used where it is normally impossible to introduce sufficient cement to seal off all fissures, and consists in pre-injection of certain chemical solutions, such as sodium silicate and aluminum sulphate; discussion of shaft sinking in Scotland, using this process; further applications of cementation, such as shaft drying, drifting in water-bearing ground, underground dams, sealing off underground fires, and construction of shaft plugs.—E.I.S., New York.

•

Shaft Sinking—The Unwatering, Sinking and Cementation of Lyme Pits, Haydock. J. Gardner. *Iron and Coal Trades Rev.,* Vol. 120, No. 3233, Feb. 14, 1930. See also *Colliery Guardian,* Vol. 140, No. 3607, Feb. 14, 1930.

DESCRIPTION of reopening and sinking 3 shafts begun in 1876, presumably for operation of coal mines; outbreak of sand; reinforced-concrete linings; features of linings; pumping arrangements. Abstract of paper read before Manchester Geol. and Min. Soc.—E.I.S., New York.

•

Rock Drilling: Dust Collectors — Rendering Harmless the Dust Created by Pneumatic Drills. V. P. Phelps. *Iron and Coal Trades Rev.,* Vol. 120, No. 3233, Feb. 14, 1930.

DISCUSSION of various methods tried for preventing dangerous dust escaping into air during drilling operation; tabular data on dust counts taken during drilling operation; description of Hay dust trap as used in connection with Jackhamer rock drill; rubber cup-shaped hood is used to cover mouth of drill hole; suction tube draws dust and causes it to pass into flannel bag, similar to that used in domestic vacuum cleaner.—E.I.S., New York.

•

Iron Mines and Mining: Norway—The Sydvaranger Iron-Ore Mines. *Iron and Coal Trades Rev.,* Vol. 120, No. 3233, Feb. 14, 1930.

GENERAL description of iron mines, surface plants and district in extreme northeastern part of Norway; deposit now being worked has surface area 406,650 sq.yd. and ore has been proved by boring to depth of 750 ft.; average content of iron estimated 34 or 35 per cent; low-phosphorus magnetite; crushers, ball mill, tube mills, and magnetic separators, concentrate: ore, 2.3 tons to 1, dry product containing 65 per cent iron; steam-electric and hydro-electric power used.—E.I.S., New York.

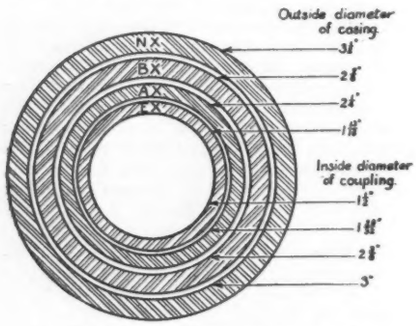
INDUSTRIAL PROGRESS

New Diamond Core Drill Standards

Robert Davis Longyear

President, Diamond Core Drill Manufacturers' Association

THE diamond core drill manufacturers have entered upon a program of simplification and standardization, which will be heartily welcomed by all who have any contact with diamond drilling. For many years the system of bit and casing sizes prevalent has worked a considerable amount of hardship on both manufacturers and consumers. This system had six principal sizes: *ES*, *E*-Mesabi, *E*, *A*, *B*, and *N*, but these sizes were not related to each other in respect to casing requirements. The largest hole, size *N*, could not be cased and continued as size *B*. It had to be reduced to size



Dimensional standards for casing and couplings

A. Likewise a *B* hole had to be reduced to *E*, and an *A* hole could not be cased and continued with a smaller diameter unless reamed. Furthermore, special sizes had been adopted by different localities, producing a diverse demand which was difficult for the manufacturer to supply promptly without carrying an unreasonably large stock. Added to all this was the difficulty the consumer faced owing to lack of interchangeability of equipment.

To seek a solution to these problems, the leading manufacturers met early in 1929. After several meetings and laboratory tests, commercial standards for North America were adopted. It is hoped that later the standards may be made world-wide.

Bits—Four standard blank bit sizes have been adopted. The outside diameters of these bits compared with the more commonly used old sizes are as follows:

New Standards, Inches		Old Sizes, Inches	
EX	1 1/16	ES	1 1/16
		E-Mesabi	1 13/32
		E	1 13/32
AX	1 13/16	A	1 13/16
BX	2 3/16	B	2 7/16
NX	2 15/16	N	2 15/16

The inside diameter of the bits has not been standardized at present, although the manufacturers will work within sufficiently narrow limits so as not to affect interchangeability. The threads are to be identical on all bits of the same size, whether for single- or double-tube core barrel, or whether of the straight-wall or beveled-wall type.

Core Barrels — Core barrels, core shells, and reaming shells are for the present not standardized except so far as the threads have to be made to conform to the standardized bit threads.

Rods—Little change has been made in drill-rod specifications. The old designations have been retained.

Casing—Dimensional standards for casing have been set up as shown in the cut. This system consists of a series of four casings nesting one within the other. The *NX* bit will pass through *NX* casing, and drills a hole large enough to be cased with *BX* casing, which in turn will admit a *BX* bit to drill a *BX* hole for *AX* casing, and so on.

To control effectively the new standards and to aid in enlisting the co-operation of the entire diamond-drilling industry, the Diamond Core Drill Manufacturers' Association has been organized, comprised of the following manufacturers:

Active Members

Diamond Drill Contracting Company, Spokane, Wash.; E. J. Longyear Company, Minneapolis, Minn.; Mott Core Drilling Company, Huntington, W. Va.; Smith and Travers, Ltd., Sudbury, Ont.; Sprague & Henwood, Scranton, Pa.; Sullivan Machinery Company, Chicago, Ill.

Official emblem of the Association

Associate Members

Acker Drilling Company, Scranton, Pa.; New Ontario Garage & Machine Company, Timmins, Ont.

The officers for 1930 are: President, Robert Davis Longyear, E. J. Longyear Company; vice-president, W. J. Shank, Sprague & Henwood; permanent secretary and treasurer, C. H. Rohrbach, 90 West St., New York City.

To assist in the establishment of the standards, the association sought the services of the Bureau of Standards of the U. S. Department of Commerce. Through the valuable co-operation of I. J. Fairchild and D. R. Miller, of this bureau, it was possible to take advantage of the experience of other industries in the simplification and standardization of products. The Bureau of Standards has recently issued a publication

Table I—Nominal Dimensions

Casing, Casing Coupling, Casing Bits, C. B. Bits	Rod, Rod Couplings	Casing O. D., Inches	Casing O. D., Inches	Coupling I D., Inches	Casing Bit O. D., Inches	Core-Barrel Bit O. D., Inches	Drill Rod O. D., Inches	Diameter of Hole Made by Core-Barrel Bit (a) Inches	Approximate Diameter of Core, Inches
EX	E	1 5/16	1 11/16	1 1/16	1 13/16	1 5/16	1 5/16	1 13/16	1
AX	A	2 1/16	2 7/16	1 13/16	2 7/16	1 13/16	1 5/8	1 13/16	1 5/8
BX	B	2 7/16	2 15/16	2 3/16	2 15/16	2 5/16	1 13/16	2 5/16	1 13/16
NX	N	3 1/16	3 1/2	3	3 7/16	2 13/16	2 3/8	2 13/16	2 1/8

(a) Assuming hole 1/16 inch larger than bit.

covering the new diamond-drill standards. ("Diamond Core Drill Fittings." U. S. Department of Commerce, Bureau of Standards, Commercial Standard CS 17-30.) In Canada no official organization was found through which co-operation could be obtained.

The dimensions given in Table I are nominal. Where a definite fit is required, as between drill-rod female thread and drill-rod coupling male thread, specific allowances have been established within which the manufacturer must work. The manufacturer will use a set of official gages to check his product as he makes it. As a further safeguard to the user, and so that he may know that the fittings he requires conform with the new standards, working gages can be procured only through the Diamond Core Drill Manufacturers' Association. The association has adopted an emblem to be attached to the products made in conformity with the new standards and on packages and cartons containing standard goods. This emblem attached to any product is in effect a certification that such product complies with the established standards. Emblems are supplied only to manufacturers who have purchased the necessary gages for producing the new standard diamond core drill fittings.

The new standards simplify and reduce the inventory requirements of users. In the past, considering the matter of outside diameters and threads alone, there have been more than twenty different types of bits for drilling holes three inches in diameter or less. Under the new standards, there are only four.

Under the old system, an *N* hole (approximately 3 in.) could be cased and reduced only once without making special casing and bits. Under the new standards, the *NX* hole can be cased and reduced three times. Under the old system, moreover, there was no assurance that a blank bit of one manufacturer would fit the core barrel or core shell of another, and the custom was to make one type of thread for single-tube core barrel bits and another type of thread for double-tube bits. Now standard items are interchangeable as to fit, and all bits of one size have the same thread. A large inventory of many different items can now be replaced by a stock of relatively fewer items.

Contractors, mining and oil companies, mining engineers, geologists, and civil engineers are urged to adopt the new standards as rapidly as possible. The majority of the industry, both manufacturers and users, have already signed written acceptances. In ordering supplies, except where small amounts of the old sizes must be purchased to enable old stocks to be worked off, specifications should always call for the new standards. Members of the Association are now prepared to quote on the new equipment.

Novel Feeder Used on Bucket Loader —A Device for Taking Profiles

Also Other New Equipment

This loader has a self-feeder of novel design

EQUIPMENT announced since the last issue includes a crawler bucket loader equipped with a self-feeder of novel design, as shown in illustration. The feeder is of the continuous helical ribbon type and feeds and cleans up uniformly. The action of its self-sharpening spiral and correct cutting edge serves to cut, dig, and convey the material to the elevator buckets in a smooth, continuous, uniform stream, without blows or shocks. Adjustment is controlled by a hand wheel easily reached by the operator, who rides on a side platform.

Capacity is high, being rated at 1¾ cu.yd. per minute for sand, stone, and gravel of 1½-in. size and smaller. A 30-hp. Buda gasoline engine or a 20-hp. motor is used for driving. Crawler frames are one-piece steel castings.

The feeder is of the continuous helical ribbon type

The maker is the Link-Belt Company, Philadelphia.

A New Portable Hoist

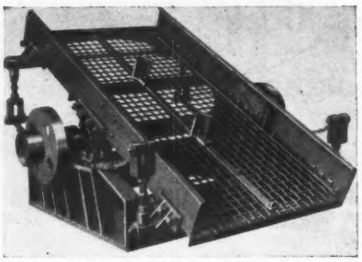
Three years ago a line of so-called "Utility" hoists in capacities up to 1,500 lb. was introduced by Ingersoll-Rand, New York, for use by miners and contractors. The company now announces the addition of a 2,000-lb. size, which makes this type of hoist available for additional kinds of work, such as hoisting timbers, tools, pipe, and drill steel into stopes and raises; hauling and spotting cars, and hoisting muck. Similar uses are found in quarries and metallurgical plants.

A radial, four-cylinder, counterbalanced piston-type air motor, which can be reversed, serves to drive the hoist. All wearing parts and cylinders are readily renewable, and the cylinders are interchangeable. The reduction gears are housed to exclude dust and run in semi-fluid grease. Ball and roller bearings are used wherever they will add to efficiency and life. A positive jaw-type clutch is provided, and a brake of the band type wraps the drum at its largest diameter. The new hoist is shown in the accompanying illustration.

This portable 2,000-lb. air hoist has many applications

New Resistors Easily Connected

Connections to rigid terminals are easily made with a new type of edgewise-wound, heavy-duty resistor recently introduced by General Electric. This resistor (CR-9132) is of the unit-box type. Advantages claimed are the unbreakable design, non-corrodible conductor, and ability to dissipate maximum heat for minimum space consumption. The new resistors are mounted on a support consisting of two steel punchings held firmly together but insulated from each other by a new form of heat-resisting molded insulation. Cleats of fired alumina insulate the resistive conductor from the support. They are locked in place after



For screening coarse materials

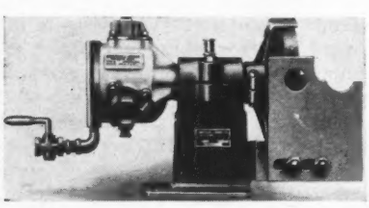
the unit is assembled by bending the projection on the support to prevent their movement. A copper connector, silver brazed to each end of the conductor, permits bolting the extreme end of the resistive material to the support. The ends of these supports, together with clamps, are said to provide ideal rigid terminal connections for interconnections and for users' leads. The line includes twenty sizes, covering a current range from 22 to 136 amp. with a corresponding resistance range of 2½ to 0.058 ohms. Four combinations are standard, as follows: without taps, with a center tap, with two taps at one-third spacing, and with three taps at one-fourth spacing.

Another Vibrating Screen

A line of vibrating screens for grading coarse materials has been introduced by Huron Industries, Inc., Alpena, Mich. It includes single- and double-deck models, with screen frames 3x6, 4x8, and 5x10 ft. in size. The vibration is said to be so transmitted to the frame that all points on the screening surface are actuated in the same plane, the movement being perpendicular to the line of flow. The vibration is caused by an eccentric drive shaft of large diameter, having roller bearings and carrying two flywheels with adjustable counterweights. This screen is shown above.

For the Shop

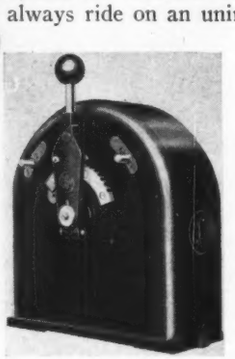
A bench-type pedestal grinder (Type 9), which can be bolted to a bench or a portable air compressor, has likewise been introduced by the company named in the foregoing. Flow of air to the motor is controlled by a hand-operated globe valve. The machine has a free speed of 3,000 r.p.m. and will take a vitrified grinding wheel 6 to 8 in. in diameter with a half-inch face. At the end of the grinder spindle, a bit chuck is screwed to take a drill or reamer with a ½-in. straight shank. The motor is ruggedly built and has three cylinders spaced radially about the center line of the spindle and delivering power to one crank pin. The cylinders are interchangeable.



An air-driven bench-type pedestal grinder

A New Master Switch

Where full speed control from the master switch is desired on cranes, hoists, or bridges, steel-mill machinery and similar applications, the new master switch introduced by the Electric Controller & Manufacturing Company, Cleveland, Ohio, may be found useful. It has been designed to give smooth and easy operation, this having been made possible by the use of ball bearings, short throw of the operating handle, absence of gears, and the fact that the contact fingers always ride on an uninterrupted plane surface. An improved roller-type centering device is provided which rides on an accurately machined notched track, making the operation so smooth and even that the operator can feel the various speed points. The width of this switch has been made as small as possible, and its general features are such as to permit a close grouping where a number of them are necessary. These switches (Type NT) are built to give a maximum of speed control in each direction with overload reset at the "off" position.



An improved master switch for cranes, hoists, etc.

Another Industrial Locomotive

Journals equipped with Timken bearings are used in a new line of gasoline-engine-driven haulage locomotives recently introduced by the Midwest Locomotive Works, Hamilton, Ohio. Main features of design and construction are uniform for the entire line, allowing for variations in size and weights of parts. The locomotives are of the single-truck outside-frame type, the one-piece frame being a semi-steel casting. Its wheels are fixed to the axles. The trucks can be adjusted to various track gages. Weight of body and frame is carried by heavy semi-elliptical springs equalized to cushion shocks. When completed, the new line will include eleven individual sizes, ranging from 4 to 25 tons. Two makes of engines are used, locomotives up to and including 12 tons having Hercules engines, and above this rating Climax engines.

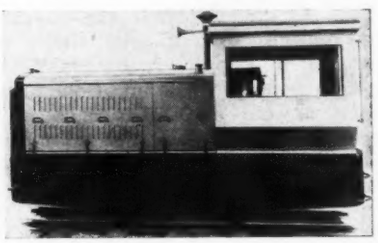
For Making Accurate Profiles

A device previously introduced abroad for taking and reproducing irregular profiles is being brought to the attention of American engineers. This is the so-called Maco template, a British invention. Is composed of a number of very thin strips of hard-drawn, solid brass, held in position by two specially constructed clamps, within which the strips may be pushed up or down so as to adapt themselves to the exact line of the profile to be taken. Each strip is only 0.007 in. thick, so that great accuracy may be obtained.

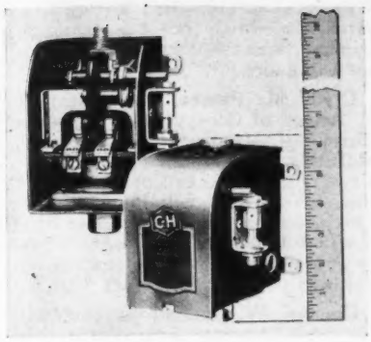
A special model of this template for mining purposes has been developed for use wherever there is a headframe. Its purpose is to determine accurately the wear on the sheave caused by the hoisting rope. In the interest of safety, it is necessary to measure this amount of wear accurately. Obviously, to take such a contour by hand would be laborious, to say nothing of being dependent upon the human element for accuracy. With the template such records can be obtained in the minimum time. The resultant contour shows no deviation from the original.

In the mining model, when the clamp is unlocked, the laminæ can slide between two aluminum retaining plates, but by means of corrugated rubber faces they are effectively prevented from falling out. In use, the locking screws are loosened and the template is gently pressed against the contour required, such as the sheave groove. The laminæ will take up the contour of the surface, and owing to their thinness this shape will be extremely accurate. The template is then locked and a perfect copy of the original contour obtained. Other and permanent templates may be made from this or the contour may be transferred to a so-called recording frame by means of a pencil. This frame is made of aluminum and shaped to hold the template together with a card on which to record the contour. Two so-called profile perfectors are supplied. These are hard wood instruments which are used after the approximate setting of the template by hand to obtain a sharply defined contour.

This device has been used extensively in South Africa, where, to comply with government regulations,



One of a new line of gasoline-engine-driven haulage locomotives, 4 to 25 tons



Single-pole pressure regulator for water, air and gas systems

periodical examinations of the hoisting sheave have to be made and records kept of the wear caused by the rope. This wear is not allowed to exceed a certain specified maximum, and to facilitate visual examination of it, a master section is supplied with the template. In the United States the device is handled by the American Maco Template Company, 44 Whitehall St., New York.

Prevent Freezing in Compressed-Air Lines

Sullivan Machinery Company announces it has secured sales rights for "Tanner-tanks" and "Tannergas." These function to prevent freezing of compressed-air lines and at the exhaust of compressed-air tools. The device consists of a tank and bypass piping connected into the air line near the point of use. The tank contains a liquid, of secret formula, which forms a gas on combination with the compressed air in the top of the tank. This gas is carried into the air lines, and is the active agent which prevents freezing at the tools.

For Regulating Pressure of Air and Water

A new single-pole pressure regulator of small size has been announced by Cutler-Hammer, Inc., Milwaukee, Wis. It can be used as a starting switch for motors up to 1 hp., 230 volts a.c. or d.c., or as a pilot switch in the control circuit of automatic starters for larger motors. It closes the circuit at low pressure and can be adjusted to open it at any pressure from 30 to 200 lb. It is suitable for maintaining pressure on systems containing water, air, gas, and similar fluids. For compressor service, a small unloader device removes the back pressure.

New Recording Instruments

Entrance into the graphic instrument field by the Roller-Smith Company, 233 Broadway, New York, is effected by introduction of two new instruments (Types AG and DG). These may be had in the switchboard, wall and portable models for direct and alternating current. Ammeters, voltmeters, single and polyphase wattmeters, and power factor meters are included. The listings cover ranges required for most graphic instrument measurements, and special ranges and types may be had.

Characteristics, as claimed, include: A sturdy dependable eight-day clock; a positive, never-failing chart drive; accessibility of all parts; light, rigid cases; a quickly detachable cover; an easy means of inserting ink in the well and removing the pen; magnetic damping on all types.

Tighter Seal for Blasting Machines

Improvement of its ten-cap blasting machine to make it more moisture- and dust-proof has been announced by the Hercules Powder Company. A special rubber gasket which seals case and cover has been developed as regular equipment and can be fitted to machines already in use. This machine is of the dynamo type and of pocket size.

■

For Quick and Cheap Repairs

Anything that will speed up repair work and reduce the cost of it to a minimum is found to be popular with the superintendents and shop men. An important contribution to industry along this line has been made by the developers of welding processes and tools, as often stated in these pages. This tribute, however, is not limited to welding. An engineer now stationed in a Western mining district has recently sent the following comments to the editor with respect to the use of so called "Smooth-On" products in the mining industry. He bases his remarks on observations made in various Western camps, as well as in Mexico and South America.

These products, in his opinion, because of their varied application for repair work, should be kept in stock at the warehouse or toolroom of every mining property no matter how large or small it may be. In the mine foundry many a faulty casting has been salvaged through their use. This applies especially to mine foundries in Latin America and other remote places which are generally equipped with home-made cupolas and operated by native labor.

Many mining companies use this product with good results for repairing leaky seams and rivets on solution tanks in their mills. "In Mexico," says this engineer, "I successfully repaired two Dorr thickeners, the bottoms of which were completely worn out and useless, by first placing a 3-in. layer of concrete, reinforced with chicken wire, and afterward painting it with Smooth-On concrete paint. It is widely used at the smelters for boiler, condenser and pipe repair work."

Continuing, he says that this material can be used also as a filler for screw-thread pipe joints on underground pipe work. In fact, he believes that better results can be obtained with its use than with white lead or a mixture of oil and graphite, because of its tendency to expand, thereby filling up all vacant space between the screw-threads when drying. It can also be used for repair work on cracked concrete foundations, tanks, and vats.

At mining properties in remote places where repair parts can be obtained only under difficulties many a costly shutdown can be prevented by the careful application of this material, on cracked compressor inter-cooler shells, plunger pump parts, fans, and numerous other important mining and milling machinery.

BULLETINS

Pumps—Goulds Pumps, Inc., Seneca Falls, N. Y. Bulletin No. 400. Pumpfax, a handbook on pumping.

Floodlights—Crouse-Hinds Company, Syracuse, N. Y. Catalog No. 312. Floodlights and industrial lighting units.

Extension Rail—Truscon Steel Company, Youngstown, Ohio. Leaflet on extension rails for temporary tracks.

Buckets — Hayward Company, 50 Church St., New York. Bulletin No. 700. Electric motor buckets.

Roller Bearings—Roller Bearing Company of America, Trenton, N. J. Catalog No. 40. Heliflex bearings.

Welding—General Electric Company, Schenectady, N. Y. Bulletin No. GEA-995A. Arc welding in industry.

Switches — Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Catalog 226.

Mining Machinery — Flottmann Aktiengesellschaft, Herne (Westphalia), Germany. Loose-leaf catalog.

Metallurgy — Thyle Machinery Company, 514 Bryant St., San Francisco, Calif. Bulletin No. 60. Information about slimes.

Refractory—Quigley Furnace Specialties Company, Inc., 56 West 45th St., N. Y. City. Bulletin entitled "Hytempite in the Power Plant."

Drill Steel—Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill. Booklet No. 72-K. Handbook of rock drill steel.

Controlling Apparatus—Allen Bradley Company, 494 Reed St., Milwaukee, Wis. Loose leaf bulletins. Data on electric controlling apparatus.

Stoker — Combustion Engineering Corporation, 200 Madison Ave., N. Y. C. New catalog entitled "C-E Multiple Retort Stoker."

Safety Equipment—Pulmosan Safety Equipment Corporation, 176 Johnson St., Brooklyn, N. Y. General folder on safety equipment for the protection of dust.

Personal Notes

ERLE V. DAVELER

Erle V. Daveler, general manager of Butte & Superior, has been promoted to the position of business manager of Nevada Consolidated and Utah Copper, with headquarters in New York. Mr. Daveler, who is a metallurgical engineer, had been previously connected with Alaska Gold, Ray Consolidated, Nevada Consolidated, and Utah Copper. He is succeeded at Butte by **H. D. Cooley,** who becomes assistant manager of Butte & Superior, under the supervision of Mr. Daveler. Mr. Cooley was formerly with Alaska Gold.

Charles Hardy returned to New York from Europe on April 29.

B. F. Tillson, of Franklin, N. J., is on a professional trip to Montana.

John Tyssowski announces the removal of his office to 40 Wall St., New York.

Colonel **Percy E. Barbour** has returned to New York from Colorado and New Mexico.

Albert Shaw has joined the staff of the Salt Lake City branch of the Wagner Electric Company.

Weld & Liddell, consulting engineers, announce the removal of their offices to 75 West St., New York.

Sydney H. Ball, of Rogers, Mayer & Ball, left New York recently for a month's examination trip in the West.

Irving B. Crosby, consulting geologist, of Boston, expects to attend the World Power Conference to be held in Berlin in June.

G. C. Makovsky, formerly of the University of Leningrad, is in the United States for six months, representing the U. S. S. R.

Charles L. Lawton, general manager of the Quincy mine, has returned to Hancock, Mich., after a business visit to New York.

Albert E. Reed, of the engineering staff of the W. S. Tyler Company, has returned to the United States from South America.

Frank M. Estes, formerly general manager of Dolores Esperanza, has joined the staff of Electric Bond & Share, with headquarters at New York.

Dr. **W. O. Hotchkiss,** president of the Michigan College of Mining and Technology, has been in Washington, D. C., attending sessions of the National Research Council.

Robert Bedford, mining engineer, of Grass Valley, Calif., who recently returned from Chile, is now en route for Russia, where he will investigate possibilities of various gold-producing areas for the U. S. S. R.

Arthur B. Parsons, assistant secretary of the A.I.M.E., left New York on May 1 for two months in the copper districts of the Southwest, Utah and Nevada, to gather material for a book on the history of porphyry copper deposits.

R. W. Senger, general superintendent of the Garfield Smelter of American Smelting & Refining, has returned to Salt Lake City after a visit to the Shorey smelter of Northern Peru Mining & Smelting, at Trujillo, Peru.

James O. Elton, manager of International Smelting, at Salt Lake City, has been made a member of the Utah State Building committee. He succeeds L. S. Cates, who has resigned because of change of residence to New York.

J. E. Spurr, formerly editor in chief of *Engineering and Mining Journal,* with Mrs. Spurr and the younger members of their family, returned recently from Florida, where they spent the winter, to their home in New Rochelle, N. Y.

W. B. Maxwell, who was referred to as mill superintendent at Anyox in an article in the April 7 issue of *Engineering and Mining Journal,* is assistant to the general superintendent. **C. O. Fricker** is mill superintendent at Anyox.

A. Gronningsaeter, of Falconbridge Nickel, sailed from New York for Norway on May 2, after two months at the smelter in Sudbury. He will spend the summer at the refinery in Kristianssand, Norway, and expects to return to Toronto late in August.

Ocha Potter, superintendent of the Ahmeek division of Calumet & Hecla, sails on May 31 for South Africa, to be with his son **George Potter,** who will be operated on for injuries sustained in a recent mine accident at the Roan Antelope mine in Northern Rhodesia, where he served as mining engineer.

C. L. Berrien, who has held the position of general superintendent of mines for Anaconda Copper Mining, has been appointed to the post of assistant manager of mines. **J. J. Carrigan,** who has been chief assistant superintendent of mines, succeeds Mr. Berrien as general superintendent. These appointments are effective from May 1.

D. D. Moffat will succeed L. S. Cates as vice-president and general manager of Utah Copper. Mr. Moffat was assistant general manager of the company, to which position he was appointed in 1926. His first connection with the company was in 1910, when Boston Consolidated, of which he was general mill foreman, was absorbed by the Utah Copper Company.

Clyde M. Pearce, of Duluth; **Harry H. Angst,** of Crosby, Minn.; **Charles M. Harry,** of Montreal, Wis.; and **F. E. McIntire,** of Crystal Falls, Mich., left New York at the end of April for Moscow, where they will join **J. M. Price.** This group of engineers is one of those sent by Oglebay, Norton & Company to superintend the development of the iron-ore deposits of Soviet Russia.

Charles W. Merrill is chairman of the State Mining Board of California which was recently created. Other members of the board are **Arthur B. Foote, Harvey Mudd, Dudley Saelzer, Walter Bradley,** and **Robert Linton.** Robert Linton was elected vice-chairman and general manager, and Walter Bradley, who is state mineralogist, was made permanent secretary.

CHARLES W. MERRILL

OBITUARY

Nils Falk, secretary and treasurer of the Vanadium Corporation of America, died recently in Salisbury, Southern Rhodesia, while there on a business trip. Mr. Falk was 50 years of age.

P. A. Brady, general manager of the Crystal Copper Company, of Butte, Mont., died recently at his home in Butte. He was born in Prescott, Ont., Canada, and came to this country at the age of eighteen and engaged in the mining industry at Central City, Colo. He is survived by his widow and one daughter.

Harry T. Lewis, founder of the firm of Lewis & Walker, assayers, of Butte, Mont., died suddenly on April 12, at his home in Butte. He was born in Baltimore in 1869, and came to Anaconda with his parents at the age of sixteen. He was at one time chief chemist of the old Anaconda smelter, and in 1897 went to Dawson, Alaska, where he remained two years.

R. Frederick McClellan, who organized the party which discovered the Kennecott Copper property in Alaska, died on May 3, at the Santa Monica hospital, Santa Monica, Calif., after an illness of six weeks. At the time of his death he was chairman of the board of supervisors of Los Angeles County. He is survived by his widow and one son, R. F. McClellan, Jr.

NEWS OF THE INDUSTRY

Slump in Copper Price Not to Affect Frood Expansion

NOTWITHSTANDING the present unfavorable situation in the copper market or the threat of further reductions in price, the expansion program now nearing completion at Frood and Copper Cliff, for International Nickel Company of Canada, will go into effect this summer as originally scheduled. On his return from England last week J. L. Agnew, vice-president of the company, announced that the first operations of the new smelter will occur within two or three weeks, when the converters will be tried out. These will be followed by the reverberatory furnaces, of which there are five, going into action. Daily shipments from the Frood mine are now averaging 3,000 tons, largely high-grade copper ore. By midsummer this tonnage will be brought up to 4,500 daily, as stated in the annual report.

In view of the approaching completion of construction work, the contractors are already commencing to lay off crews. Dominion Bridge laid off 400 men recently, having completed its work at Copper Cliff and Levack. These will be followed by crews of the general contractors, Fraser Brace Engineering. Within three months, it is expected, the total construction force employed on the expansion program will be reduced between 1,200 and 1,500 men.

While in Great Britain Mr. Agnew visited the company's operating plants, the colliery at Pontardawe, Wales; the Acton precious-metal refinery; the Clydach nickel refinery; and the rolling mills at Birmingham. Although not operating to capacity, he reported these plants to be working satisfactorily, alterations in the interests of efficiency having been completed some time ago.

"The nickel business is not bad and may be described as fairly satisfactory considering conditions and as compared with the other base metals," he observed. "Business is down about 25 per cent from the corresponding level this time last year. How soon it will recover depends on general conditions and the rapidity with which industry revives throughout the world."

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New Copper Concentrator to Start Soon at Rio Tinto

Rio Tinto has completed construction of the first operating unit of a new copper concentrator at its mines at Huelva, Spain, and the new plant will soon be put into operation, according to Sir Auckland Geddes, chairman of the board. In the future the company plans to produce more of its copper from the porphyritic ores and less from the pyritic. About 5,000,000 tons of porphyritic copper ore has been proved and has been completely developed and equipped for a cost of £250,000, or about 1s. a ton. Neither the size of the new plant nor the grade of the ore has been stated.

Western Copper Mines Cutting Wages—United Verde Abandons Five-Day Week

Reductions in Pay Based on Sliding Scale Will Be Made This Month and in June—No Suspensions Announced—U. V. X. Starts Work on New 200-Ton Mill

WAGES in Western copper mines will be cut twice as a result of the recent sharp decline in copper prices. According to the sliding-scale agreements in force, most of the copper companies base wages on the preceding monthly average price of copper. Wages for May will therefore reflect in part the 18c. price that obtained through half of April, but in June they will show the full effect of the fall to 14c. How many men are affected by the cut is not known, but every important company in the West has announced its intention to follow the lead of Anaconda Copper, the first of the producers to publish the reduction.

At Butte, the basic daily wage was reduced to $5.25 on May 1, from $5.50. Mill, smelter, and refinery employees sustained the same cut of 25c., although their basic wage is not necessarily the same. A further reduction of 50c. a day will be made on June 1 if the average price does not exceed 15c. in May. The further drops in the price of copper will probably not affect wages, however, as $4.75 is the lowest level in the sliding scale that has been followed.

At the Southwestern mines, a reduction of 5 per cent was put into effect on May 1 and a further cut of 10 per cent will be made on June 1. Employees in Southwestern copper mines have no basic daily wage, as the skill of the labor employed varies widely.

Utah Copper, and its railroad subsidiary, the Bingham & Garfield Railroad Company, will not reduce wages until May 10. On that date all employees receiving $4.75 a day or more will suffer a reduction of 25c. in their wages and employees receiving less than $4.75 will be reduced 20c. Salaried employees will also sustain a cut. More than 2,000 men will be affected.

No action has yet been taken as to wage cuts in the Michigan copper district. When the price of copper was advanced last year, the Michigan district did not increase wages at the same time as the Western mines. One advance of 10 per cent was made at about the time that copper reached a price of 17c. a pound. Eventually a cut in wages is expected. Possibly the operating companies are waiting until the first of June to make it.

United Verde, operating at Jerome, Ariz., has decided to revert to the six-day week, according to W. V. De Camp, general manager of the company, after having tried the five-day throughout April, so as to prevent unemployment that would otherwise result from its curtailment plan. Evidently, output will be increased slightly, although only two reverberatory furnaces will be maintained in operation at the smelter. The company will continue a maximum amount of development and construction work.

Steel work has been started on the new 500-ton unit of the concentrator, now consisting of two units built in 1926 at a cost of $900,000. Cost of the new unit is estimated at $250,000. It will not duplicate the existing plant, but will permit treatment of zinc ore and is the first step in the program for zinc production from the United Verde mine that is expected to result in construction of an electrolytic zinc plant. To build the new unit, 5,000 cu.yd. of dirt has been removed and 600 cu.yd. of concrete poured for the foundation and floors of the building. Structural steel was fabricated in the company's shops.

In addition, the company is building 40 new houses for employees at Clarkdale, the contract having been let to Hoggan & Farmer, of Phoenix, at an estimated cost of $150,000. Of the houses, 23 will be of English architecture and 17 will be Spanish in design. Construction is expected to be complete by the end of the summer.

At the adjoining United Verde Extension mine, work has started on a new 200-ton flotation plant to treat siliceous sulphide ore from the shear zone of the Verde fault on the 1,200 level. The primary object of the mill will be to remove the silica from the ore, and the ratio of concentration will therefore be low. About 80 tons of concentrate will be produced daily. Construction is expected to be completed in three months. Only two men per shift will be needed to operate the plant. Smelter crushing equipment will be used to reduce the milling ore to ½-in. size, and one of the smelter bins will be used for a mill bin. The tonnage of known and probable mill-grade ore in the mine is small, and the company evidently intends working it on a scale which will result in exhaustion at about the same time as the high-grade smelter reserves, now about a two years' supply.

No information has yet been received indicating that any large American copper mine has been forced to close because of the drop of several cents in the price of copper.

North Butte Mining, which reopened its property at Butte, Mont., in the fall of 1928, when the price of copper was rising, may not be able to make a profit at current levels. Shipments will be reduced somewhat, although development will be continued. In March the company produced 10,000 tons of copper ore from its Granite Mountain mine.

Trade Depression Chief Concern at Chamber of Commerce Meeting

LACKING the smug complacency much in evidence a year ago, 2,500 of the nation's business leaders assembled in Washington on April 29 for the eighteenth annual meeting of the Chamber of Commerce of the United States. Alertness, born of the strenuous experiences of the last six months, characterized the round-table discussion. Coupled with this was outspoken opposition to the assumption of too much credit for what the Chamber has done in its National Business Survey Conference. A very general feeling was that chief credit should go to President Hoover, whose thought it was to organize to meet the emergency and whose enjoyment of public confidence made it possible to stem the tide of panic, which, at first, promised to assume the proportions of that of 1907.

Alexander Legge, chairman of the Federal Farm Board, some of whose policies have been criticized caustically by officials of the Chamber, hit out straight from the shoulder. "Entirely too many of your members were for the principle of co-operation only so long as it did not work," he said. "When it became apparent that a means had been provided that really would help the farmer to get organized co-operatively, so that he, like other producers, would have some voice in determining the sale price of his commodity, the effort was branded as government price-fixing and the putting of the government in business. All of this was in the face of the fact that you had declared unmistakably, only a year previously, for the principle of co-operative marketing."

The round-table conference on April 29 developed only one resolution. It grew out of the discussion of natural resources industries, and reads as follows:

"Resolved, that the natural resources round-table recommends to the board of directors of the Chamber of Commerce of the United States that it authorize an immediate study upon which may be based a recommendation for a national policy toward reasonable conservation of natural resources, including the necessary and appropriate legislation."

A plain and honest voicing of Canadian thought against the United States tariff was given during the Thursday afternoon session by Lieut.-Col. J. H. Woods, president of the Canadian Chamber of Commerce. Pointing out the unfortunate part that political ineptitude has played in breaking down the natural economic unity of the two nations, he stated that the proposed tariff is about to cut Canadian trade by $75,000,000 annually. This means a reduction of 20 per cent in Canada's trade with the United States, which runs in the neighborhood of $400,000,000. Obviously, our exports to Canada, which aggregate $800,000,000, or twice as much as the imports, will suffer to a corresponding degree.

Without veneer, Colonel Woods urged that the two nations should work together toward a more equitable and sensible way of doing business. He quoted Prof. Arthur Taussig to the general effect that the friendship, built up through tourist travel and the gradual enlargement of contact with Canada, is hard to maintain in the face of legislative hysteria prompted by American business men. Colonel Woods said that he could not subscribe to this idea to the extent that Canada would become generally embittered over a tariff squabble. Nevertheless, he asserted that relations with Canada have been too long overlooked by American business.

Merge Properties Near Boulder

Four properties in the Sugar Loaf district, near Boulder, Colo., have been merged by Electra Engineering & Development. An abandoned tunnel, 2,600 ft. long, on one of the properties will be extended 400 ft. in the hope of striking the Logan vein 600 ft. below the deepest workings previously driven on it. Gold and silver are the chief metal content.

■ ■ ■

Silver Tariff Defeated in House—Fate Now Rests With Conference

AFTER a short debate on May 2, the House of Representatives defeated the motion to accept the silver tariff of 30c. an ounce, voted in the Senate. This means that the silver duty goes to the conference committee with the House recommending that it remain duty free. This silver tariff, proposed by Senator Key Pittman, of Nevada, was originally defeated 36 to 32 in the Senate, but was later passed by a vote of 55 to 12 after Senator Pittman had given a detailed description of the disastrous effect of low silver prices in the West. When the tariff bill was submitted to the conference committee the silver duty was referred to the House of Representatives for a vote, although several other provisions affecting mineral products—notably zinc and manganese ores—were accepted with the Senate rates, even though the House had voted no duties on them.

The vote on the silver duty in the House was 72 in favor, and 202 against. In advocating silver protection, Representative Taylor, of Colorado, said that it is the only tariff item that will help the Rocky Mountain states. Representative Evans, of Montana, said that a silver duty would increase employment in Western mines. Representative Martin, of Massachusetts, who spoke against the duty, said that it would require compensatory rates on silver jewelry, or the duty of 65 per cent, ad valorem, now in effect, would not protect domestic jewelry manufacturers.

The accompanying table indicates the duties on the several mineral products as finally agreed upon by the conference committee. With the exception of silver, these duties are probably the ones that will be contained in the tariff bill when it is submitted to President Hoover for approval.

Tariff Changes

Commodity	Act of 1922	Proposed
Chromium, over 0.2%	.....	3c. per lb.
Manganese ore, 10 to 30%	Free	1c. per lb.
Metallic manganese		
Tungsten, metal, etc.	60c. per lb.	60c. per lb.
	over 25%	over 40%
Silicon aluminum:		
Aluminum chief value.	5c. per lb.	5c. per lb.
Alum. not chief value.	Free	5c. per lb.
Alum., crude and alloys.	5c. per lb.	4c. per lb.
Aluminum shapes	9c. per lb.	7c. per lb.
Aluminum foil	35%	40%
Nickel oxide	1c. per lb.	Free
Zinc ore:		
Less than 10%	Free	1½c. per lb.
10–20%	½c. per lb.	1½c. per lb.
20–25%	1c. per lb.	1½c. per lb.
Pyrites, over 3%	Free	1½c. per lb.
Crude magnesite	0.3125c. per lb.	0.46875c. per lb.
Bentonite, unmanufactured	$1 per ton	$1.50 per ton
Bentonite, manufactured	$2 per ton	$3.25 per ton
Feldspar, crude	Free	$1 per ton
Silica, crude	$4 per ton	$3.50 per ton
Mica, manufactured	25%	4c. per lb. and 25%
Mica, cut or stamped	30%	40%
Mica films, uncut:		
Less than 12/10000-in.	30%	25%
More than 12/10000-in.	30%	40%
Mica films, cut	30%	45%
Graphite:		
Crystalline lump, chip, or dust	20%	25%
Crystalline, flake	1½c. per lb.	25%
Not yet confirmed:		
Silver	Free	30c. per ounce.

■

Small Tintic Mines Close

Work has been temporarily suspended at the Eagle & Blue Bell, Victoria, and Bullion Beck mines of U. S. Smelting, Refining & Mining in the Tintic district, Utah, because of prevailing low metal prices. About 75 men are affected.

■

Unwater Cuban Gold Property

American Metal is now unwatering the Rey de Victoria gold property, in the Province of Oriente, Cuba, to permit an examination of the workings, prior to more extensive exploration. The company has taken an option on the mine, which is said to have yielded some high assays. American Metal operates the Minas de Matahambre copper property, at present the only important nonferrous metal producer in Cuba.

■

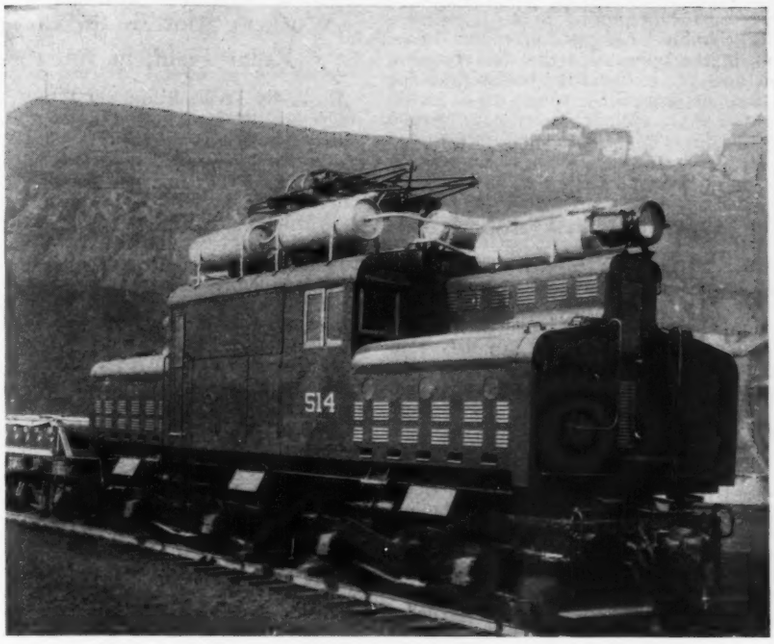
Will Destroy Old Nevada Stack

Visitors attending the celebration for the opening of the Transcontinental Highway at Ely, Nev., on June 4 and 5 may also witness a very interesting spectacle at McGill—namely, the destruction of the old 300-ft. smokestack of Nevada Consolidated Copper. This stack and a 1,000-ft. brick-flue system, which is now being cleaned out and dismantled, have been in continuous operation since 1913, handling roaster gases. They are now obsolete because of the recent installation of a new Cottrell plant and smokestack.

■

Cates Honored at Banquet

More than 275 leading mining and business men from all parts of Utah attended the farewell dinner given in honor of Louis S. Cates, retiring vice-president and general manager of Utah Copper, at the Salt Lake City Chamber of Commerce on April 25. Among the speakers who paid tribute to Mr. Cates for the excellent work he has performed for the copper industry in Utah during the last 27 years were Governor George H. Dern of Utah; Mayor John F. Bowman of Salt Lake City; Lafayette Hanchett, chairman of Utah Power & Light Company; Anthony W. Ivins; Ralph Bristol, and Harold Fabian, who presided.



One of three new locomotives ordered for use at Chuquicamata

Add Three 600-Hp. Locomotives to Chile Ex. Rolling Stock

Three 77-ton, 600-hp. electric locomotives have been ordered by Chile Exploration for use at its mine, near Chuquicamata, Chile. They will be used to haul copper ore from the mine to the metallurgical plants and will supplement six similar locomotives ordered in 1926. Westinghouse Electric & Manufacturing Company is providing the new locomotives, designed to operate from overhead trolley, third rail, or storage battery. The storage batteries are under the hoods and are used at locations in the mine where installation of either third rail or overhead wires would be impracticable. A motor-generator set to recharge the fourteen tons of storage batteries is included in the locomotive equipment. Tanks on top of the locomotives carry compressed air for the operation of brakes and dumping the trailing cars.

During 1929, $2,346,258 was spent on construction expenditures at Chile Ex. This was the largest amount spent at any of the Anaconda-controlled mines.

■

Copper Struck in Coeur d'Alene

Drifting on a porphyry vein on the property of General Mines, in the Coeur d'Alene district of Idaho, for a distance of 200 ft. has exposed a considerable amount of copper-silver-gold ore, according to J. B. Platts, mining engineer of the company. A considerable body of mill-grade ore has been indicated and enough high-grade ore may be found to justify direct shipments to a smelter. The ore is unusual in its high copper and gold contents, as most Coeur d'Alene ore carries only silver and lead, or silver, lead, and zinc in commercial quantities. The drift will be continued as long as it remains in ore, and then a crosscut will be driven to the north wall of the vein, said to be 41 ft. wide. In addition to this ore, the company has cut two veins in its 1,800-ft. No. 3 tunnel. One of these, which carried no ore where cut, is apparently an extension of the productive vein in the Page mine of Federal Mining & Smelting.

■

A. S. & R. Starts New Mill for Carbonate Ore at Chihuahua

Operation of the new 300-ton concentrator of American Smelting & Refining at Chihuahua, State of Chihuahua, Mexico, was started early in April. This plant will treat carbonate silver-lead ore, also containing some tin, from the company's Santa Eulalia mine. Flotation and gravity concentration are both used. The production of tin is of interest, as this plant will probably have the largest output on the North American continent.

Curtailment, both of production and of the number of men employed, is being put into force at some of the company's Mexican properties because of the low metal prices. Some time ago the Veta Grande unit was closed, and more recently the Asientos property, in Aguascalientes, suspended operations. Development work is being continued at the various properties, including the sinking of a new 2,200-ft. shaft at the San Pedro mine, in San Luis Potosi.

■

U. V. X. Cuts Ore in Idaho

United Verde Extension has cut ore in its crosscut tunnel at the Golden Anchor mine, which it is exploring under option in Idaho. Development work done along the vein to date has shown ore 3 ft. wide, averaging 1 to 1.5 oz. of gold a ton, with some spots of much higher grade ore. Drifting on the vein is in progress and the oreshoot is expected to be about 150 ft. long. A raise to the bottom of the Holt winze from the crosscut tunnel has been started. The vertical distance is about 450 ft.

To Drill Nickel-Copper Deposit on West Coast of Hudson Bay

Cyril Knight Prospecting has awarded a contract for a minimum of 2,000 ft. of diamond drilling to Smith and Travers, of Sudbury, Ont., for testing out a large copper-nickel sulphide body on its claims at Rankin Inlet, 300 miles north of Churchill, on the west coast of Hudson Bay. A large steel boat has been purchased and will be shipped on July 1 to Churchill, where it will be loaded with the drill and supplies. By that date the west coast of Hudson Bay is expected to be open for navigation. This is the first time that a diamond drill will have penetrated into the region. A tri-weekly railroad service for freight and passengers between The Pas, Manitoba, and Churchill will be initiated on May 3, according to word from Canadian National Railway officials.

■

Preliminary Hearing Held in Canadian Brokerage Case

In the preliminary hearing in the trial of W. J. Smart and M. E. Young, of Homer L. Gibson & Company, Toronto, two of the brokers arrested in the clean-up by the Attorney General's Department of Ontario, sufficient evidence was given to establish a *prima facie* case, and the accused will have to stand trial. Detailed and technical evidence was presented to show the position of the company, and the Attorney General's Department stated that on July 1, 1929, the firm was short $8,000,000. On the same date the firm was said to have been short 198,608 shares of Teck-Hughes sold. It had received $1,716,000 from customers to purchase this stock and later the firm made the purchase to balance the accounts at a cost of $1,147,000, showing a profit to the firm of $568,000. On Sept. 4, when Smart and Young took charge of the business, the company's short position had been reduced to $3,500,000 and on Jan. 21, when they were arrested, this short position had been reduced to $2,700,000.

■

Drilling Adds 1,000 Ft. to Depth of Sullivan Orebody

Diamond drilling from the 3,900 level of the Sullivan lead-zinc mine has cut ore at a point 1,000 ft. vertically lower, according to a report made by Consolidated Mining & Smelting to the Minister of Mines of British Columbia. Grade and width are stated to be "commercial." The 3,900 level was the greatest depth to which ore had been proved previously. The drilling also proves that ore extends more than 2,000 ft. below the present working tunnel on the dip.

Production from the Sullivan mine has been maintained despite the slump in the prices of lead and zinc, its principal products. J. J. Warren, president of the company, has announced that Consolidated will neither cut its working force nor reduce wages, although he anticipates at least another year of depressed metal prices. Shipments to Trail from the 6,000-ton Sullivan mill, according to the company's official figures, were at the highest rate in March since last October. Shipments in that month were 47,853 tons. April shipments were 40,296 tons.

Lena Goldfields Employees Admit Sabotage in Russia

Reports from Moscow, Russia, to the New York *Times* state that four employees of Lena Goldfields, the English company holding concessions in the Ural Mountains, have pleaded guilty to charges of sabotage and espionage. One of the workers admits having set fire to the Ridder zinc plant, belonging to the Soviet government, but he alleges having done so at the instigation of a British engineer. Another testified that work on the Lena concession was carried on inefficiently because of lack of capital and desire to obtain quick results in production. Much gold, he stated, was stolen by volunteer workmen. Representatives of the Lena company and of the Soviet government are now meeting in Berlin to arrange for the termination of the concession.

■

St. John del Rey Increased Ore Reserves in 1929

St. John del Rey Mining estimates ore reserves in its Morro Velho mine, in Brazil, as 1,455,200 tons at the end of 1929, compared with 1,171,500 tons at the end of 1928. During 1929, 169,454 tons was extracted. The increase in reserves is due largely to development of the northwest orebody on the "25" level, the next to the deepest level in the mine, and to a new orebody struck southeast of the main lode on the "22" level. Work on the "26" level to date has indicated that the northwest orebody is of lower grade than above. Both Guy N. Bjorge and Prof. L. C. Graton, who have recently examined the property, have expressed a definite opinion in favor of the continuation of the lode to greater depths. Plans for mining below the "26" level will not be made until the orebody has been fully developed there. Because of the present poor condition of the coffee industry, the labor supply at Morro Velho has been considerably improved.

■

Wright-Hargreaves Remodeling Plant at Kirkland Lake

Wright-Hargreaves, at Kirkland Lake, Ont., will spend $100,000 to provide extra grinding, settling, and filtering capacity. These additions to the mill are not for the purpose of increasing tonnage but to give finer grinding and longer treatment. They are expected to result in a saving of 50c. a ton, which will pay for the equipment in one year. The property is making remarkably good progress and, at the eastern end of the mine particularly, opening up substantial amounts of new ore. Mill heads are up to about $13 a ton. If the present rate of production is continued, the mine should establish a new production record this year.

In spite of heavy development costs, which are all charged to current operating costs, profits are running $75,000 a month. With $1,000,000 cash in the treasury, it is anticipated that a dividend will be paid during the current year. The shafts will be continued to 3,000 ft., the limit of the capacity of the present hoists, and several new levels will be opened up. By the end of this year, or the beginning of next, tonnage will probably be stepped up to 700 a day, and, in the opinion of the management, this does not exhaust the possibilities for further expansion.

■

New Dome Mill Should Be Operating in October

Operation of the new 1,500-ton plant that Dome Mines has decided to build at its mine in the Porcupine district of Ontario will probably be started in October of this year, unless unforeseen delays in construction occur. Cost of the new plant will be about $600,000, which is less than the old plant, burned last year, cost. During the first four months of this year, the company has added 275,000 tons of ore to its reserves, bringing the total reserve available for the new plant to about three and a half years' supply at capacity. This comparatively short known life was undoubtedly the deciding factor in the decision to make the new mill of relatively cheap construction. Gold will be recovered entirely by cyanidation, eliminating stamps.

■

Merge Gold Circle Consolidated With Betty O'Neal Mines

Gold Circle Consolidated has acquired the properties of Betty O'Neal Mines, at Lewis, Nev., and Prescott, Ariz., by offering three shares of its own stock for each two shares of Betty O'Neal stock held. The Betty O'Neal mine, at Lewis, Nev., is equipped with a 200-ton flotation plant and a 660-hp. semi-Diesel power plant. It has produced $2,287,000, largely in silver, although some lead, copper, and zinc have been recovered. The Prescott property, known as the Cash mine, is equipped with a small ten-stamp mill. A new tunnel will be driven at the property to cut the thirteen veins indicated on the surface. Production to date has come largely from one vein.

The Gold Circle properties, in Elko County, Nev., have produced $587,791 in gold since the new 75-ton cyanide mill was put in operation in 1927. Development work is being continued, chiefly in the Elko Prince and Colorado Grande mines. An issue of 50,000 shares of stock is being made to finance further development work. The public will be offered the stock at $3 a share and the stockholders will be offered it at $2 for each ten shares of stock held.

The Betty O'Neal mill was closed six weeks ago and the Gold Circle plant suspended operations in August, 1929. With the additional funds, the company intends continuing the Getchell tunnel, at Betty O'Neal, through the fault that cut off the orebodies mined on upper levels. At Gold Circle, the Elko Prince shaft will be unwatered and deepened from 900 to 1,200 ft. The Grant shaft will also be deepened from 225 to 425 ft.

■

Shenandoah-Dives at Capacity

Operation of the new 300-ton mill of Shenandoah-Dives Mining, at Silverton, Colo., has been at capacity since the middle of March. The plant was started on Feb. 24. Results of its operation are being awaited with much interest by Colorado mining men. Copper and gold are the chief metals produced.

Workers Riot in Strike on Kolar Field, in India

Riots by striking miners from properties on the Kolar gold field, Mysore, India, resulted in 45 casualties on April 7. Since then the situation has improved. At a meeting held between mine officials and leaders in the community, on April 15, the disputed questions were in large measure settled and an early resumption of production by the five producing mines is expected. Output of the five leading mines in 1929 was 363,271 oz., a small decline from the preceding year.

Annual meetings of three of the Kolar gold mines — Ooregum, Nundydroog, and Balaghat—were held last month in London. Ooregum Gold reports a slight decrease in ore reserves from 295,000 tons to 270,000 tons at the end of 1929. About 500 tons is milled daily, in addition to about 650 tons of tailing-dump material. The company has developed its orebody on the Nos. 71 and 72 levels and is now drifting on the No. 73 level. Development work is being pushed and will probably be started on the No. 75 level before the end of the year. Definite improvement has been noted in the central section of the property on the deeper levels.

Nundydroog Mines increased ore reserves by 19,000 tons, to 265,000 tons, at the end of 1929. Although the milling rate is only about 350 tons daily, together with re-treatment of about 600 tons of tailing daily, production is about the same as at Ooregum—80,000 oz. annually. A new discovery has been made in the Kennedy section of the mine, on the No. 54 level. It has been drifted on for 282 ft., shows an average width of 32 in., and assays about 28 dwt. per ton. Development in the Oriental section on the Nos. 51 and 53 levels has also been satisfactory.

Production from the Balaghat Gold property is on a smaller scale than at either of the two other mines, being only about 150 tons of ore daily. Development work has been hindered by water below the No. 51 level, and reserves show a decrease of 18,000 tons to 56,000 tons, or only about a year's supply. Sinking of the No. 3 winze at the south end of the property has reached the No. 54 level and drifting has been done on the Nos. 48, 51, 52 and 53 levels. At the No. 48 level a discovery has been made that the management believes may be the fringe of a new orebody.

■

Rosebery Mill Completed

Electrolytic Zinc has contracted with the Emu Bay railroad for transportation of zinc and lead concentrates from its new 550-ton mill at Rosebery, Tasmania, Australia, to the port of Burnie, a distance of 90 miles. From Burnie, the lead concentrate will be shipped to Port Pirie for treatment by Broken Hill Associated Smelters and the zinc concentrate will be shipped to Electrolytic Zinc's Risdon plant. The railroad company has purchased three new Garratt locomotives to cope with this increased traffic. Construction of the concentrator has been completed, but operations will not be started until all transportation facilities are completed, probably some time in May.

Security Shaft Strikes Water

Sinking of a new vertical shaft at the Eastern Star property, at Gold Circle, Nev., by Security Mining, which recently acquired the property, struck water at a depth of 130 ft. A 500-g.p.m. centrifugal pump has now been installed in an old 250-ft. incline shaft on the property, and the management hopes to be able to resume sinking of the new shaft soon. N. H. Getchell, of Gold Circle Consolidated, is also general manager for Security Mining.

Atlas to Build Tramway

Atlas Mining, operating in the Coeur d'Alene district, Idaho, is installing a 1,400-ft. cable tramway to connect the portal of its tunnel with the Gold Hunter concentrator, near Mullan, Idaho. The equipment, which is being furnished by the Riblet Tramway Company, is expected to be completed for operation in July. Atlas Mining recently struck a silver-lead orebody, 8 ft. wide, in a drift from the main tunnel.

The Wernecke silver lead concentrator, near Mayo, Yukon

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Mines Outside Cripple Creek Ship Ore to Golden Cycle

About 1,400 tons of ore is being shipped monthly to the Golden Cycle mill at Colorado Springs, Colo., from localities other than Cripple Creek, and L. S. Harner, superintendent of the company, says that the proportion of such shipments is showing a steady increase. Until last fall, when a 200-ton complex-ore flotation unit was installed at the plant, almost all ore treated at Golden Cycle came from Cripple Creek. Now slightly more than 5 per cent is coming from outside mines. More than 100,000 tons in all were milled in the first four months of 1930. At present about 800 tons is being milled daily, or two-thirds of capacity. Last year $252,000 was paid in dividends.

■

Would Build Power Plant in Hinsdale County, Colo.

R. D. Webb, of Minden, La., has filed plans with the state Public Utilities Commission for a hydro-electric power plant in Hinsdale County, Colo., to cost $300,000. In addition, he has an option on the properties of Hinsdale Mining & Development, which include a small power plant. Construction of the new plant will be completed within a year of the date approval for the plans is given. Power would be furnished to Mr. Webb's mining properties, the town of Lake City, and any other users within a radius of 30 miles. Empire Chief and Ute & Ulay are the two principal mining properties in the Lake City area.

■

Arizona Chapter Visits Bisbee

On April 28 and 29, a meeting of the Arizona chapter of the American Mining Congress was held in the Bisbee district. The Phelps Dodge, Calumet & Arizona, and Shattuck Denn companies co-operated to prepare a technical program of interest, which was presented on April 28. The following day the members made a trip of inspection through the mines and metallurgical plants of the district. In addition, a meeting on safety work was held in the morning. On both days of the meeting, a banquet was held in the evening at the Club Social, Agua Prieta, Sonora, Mexico.

■

Build New Quicksilver Plant in Morton District

Consolidated Mercury Mining is constructing a 100-ton plant to treat cinnabar ore from its properties in the Morton quicksilver district of Washington, according to F. B. Prescott, president of the company. Operation is expected to start in June of this year. The company's holdings, consisting of more than 1,100 acres, were acquired from Barnum-McDonnell Mercury, which operated a small plant from 1925 to 1929, with a production of 1,265 flasks of quicksilver. The adjoining Morton Cinnabar plant has produced 2,500 flasks in the last two years from a 30-ton Gould furnace.

■

Amparo Ore Reserves Low

By far the greatest part of the ore remaining in the Amparo Mining property, at Etzatlan, Jalisco, Mexico, consists of pillars, wall-slabs, and fill in caved stopes of the known orebodies, according to Emil Grebe, superintendent. Exploratory work to find new ore is being carried out in search for the San Juan-Dulces Nombre oreshoot on the 1,100 level. Work on the Posesion and Misericordia orebodies is being undertaken at about the 700 level. The estimated tonnage available for mining at the end of 1929 was 101,500 metric tons, with an average grade of 225 grams of silver and 4.05 grams of gold per ton. Production averages 200 tons of ore daily. The present low price of silver is causing a small operating loss.

New York Section Discusses Licensing of Engineers

At the monthly meeting of the New York section of the A.I.M.E., on April 23, Arthur V. Sheridan, president of the American Association of Engineers, and V. T. Boughton, managing editor of *Engineering News-Record,* spoke on "Licensing of Professional Engineers." Both speakers urged the mining engineers to see that their interests were not submerged in the laws that are sure to be enacted on this subject. Examples were cited of how threatening legislative measures had been averted by vigilance and timely action, and the speakers warned against the increasing tendency of certain groups to encroach upon the rights of professional engineers. Col. Walter G. Eliot, until recently a member of the Board of Examiners of Engineers, in the ensuing discussion gave a review of the work required to have the present licensing law in New York State put into effect, and he said that the proposed changes in the law, if adopted, would be a decided improvement. He also explained the procedure of examining the applicants for license, ending with an earnest plea for the law. Major D. M. Oltarsh spoke strongly in favor of taking action and wanted the members to express themselves in favor of the law. The main objection raised against licensing was in regard to the possible annoyance and expense entailed, especially where a man's work was not confined to one state.

No definite action was taken, as the matter was considered too important to be decided by so small a representation of the membership. The view was expressed that direct action by the local section might not meet the approval of the national organization, important principles being involved. A prevalent sentiment for further consideration and discussion of the question was, however, noticeable. A fund of $1,000, collected some years ago to oppose licensing laws, remains to be disposed of.

■

Cut Output at Tybo Mines

Because of the low prices prevailing for all three of its products—silver, lead, and zinc—the Tybo unit of Treadwell Yukon, in Nevada, has put its concentrator on a one-shift basis and reduced its working force to 100 from about 165. The mill had been handling about 350 tons of ore daily, and producing from 60 to 70 tons of concentrate. Because of the smaller concentrate output—only about 15 tons daily—only one truck and trailer will be used by the Golden Gate Motor Transport Company to haul the production from Tybo to Tonopah for shipment. Formerly four trucks were used.

Production of ore to date has come almost exclusively from the Nos. 3 and 7 levels. Shaft sinking to the No. 8 level has been completed and pockets are now being cut at that depth by the shaft crew.

■

To Study Isle Royale Further

University of Michigan scientists will make a study of three prehistoric village sites on Isle Royale, in Lake Superior, this summer in the hope of finding further clews as to the identity of the ancient tribes which mined native copper on the island. The sites, which were investigated by an exploring party last year, will be excavated. Evidence of mining long before the coming of the American Indian has been found, but nothing is known of the racial character of the ancient miners.

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

London Takes Gloomy Outlook on Metal Situation

London, April 26.—The general feeling here seems to be that the metal markets still have trouble ahead of them. The fall in the prices of most of the metals is said to have hit many mining companies hard. Financing appears to be the major question, as accumulated stocks are heavy and the companies will need sound resources to tide them over until these stocks have been dissipated. Cut in the price of copper on the New York market, although not unexpected, has upset the copper shares here Rio Tinto, at present the largest British-controlled copper producer, is now quoted at £42 10s. per share, as compared with a high in 1929 of about £63 2s.

. . . . Restriction of tin production is said to be already effective. Support to this movement is being given in all producing countries. Lead is wobbly on the London market and is inclined to weaken because of the large imports, large stocks, and the low price of silver, which makes producers anxious to convert their accumulated lead into cash.

. . . . At the meeting of synthetic and Chilean producers of nitrate in Paris, data on costs were presented. The synthetic producers are said to be comparatively high-cost, which is rather contrary to general impressions. The Chilean companies want to clear stocks, which are at a high point, and they are willing to cut the price for a year to the extent of 1s. or more per metric quintal.

. . . . The Austrian government has granted a concession on the enormous beryllium deposit at Koflach, Austria, to the Beryllium Company of Austria, in which New York and Cologne interests have control. The company will employ a new electrical process, invented by Dr. Seidler, of Cologne, for treating the beryllium ore. American reports that General Electric was interested in the deposit are denied as incorrect.

. . . . On April 28, the Panama Corporation will issue 250,000 shares of £1 par to provide for erection of metallurgical plants and continuation of development work. Hugh Marriott, director of the company, has returned to London from the properties and reports conditions as highly satisfactory. American capital is apparently uninterested in the possibilities.

. . . . Discovery of a hematite quartz lode at Edjudina, in Western Australia, bordering Lake Carey, is reported here. An auriferous belt is said to have been traced for a length of several miles, with a width of one mile.

. . . . Last year's work was no criterion of the results that may be obtained from operation of the plants of the Chemical & Metallurgical Corporation, near Runcorn, England, according to statements made at the company's annual meeting, as successful operation in the short time the plants have been at work is not to be expected. Difficulties over ore treatment arose and the chemical side is now being investigated. The company has operated a lead smelter for several years, and has more recently built a plant to produce metallic platinum.

. . . . The British government is investigating the conditions of the lead-mining industry at Lanarkshire, Scotland. Construction of a central pumping plant to drain the entire group of mines is being considered.

. . . . Termination of the Lena Goldfields concession in Soviet Russia will be discussed at a meeting in Berlin of the representatives of the Soviet government and the company.

■

Patiño Adds Compressor Unit; New Monserrat Mill Starts

La Paz, Bolivia, April 26.—Patiño Mines & Enterprises, in the Uncia district, is building an additional compressor plant with a capacity of 7,000 cu.ft. a minute. The new sorting plant at the mouth of the Siglo XX tunnel has been completed. It has a capacity of 3,000 tons of ore daily. The maximum tonnage handled in the concentrator in any one month to date has been about 2,175 tons daily. Patiño is gradually becoming a large-scale, low-grade enterprise, and the installation of new power and concentrating facilities indicates the necessity for handling a larger tonnage of ore to obtain the same amount of metal as in former years.

. . . . The new 160-ton concentrator of Monserrat Mining, between Pazna and Poopo, has been started and is now handling a complex tin-silver-zinc ore. Both flotation and gravity concentration are used. About 50 per cent of the tin content is teallite—sulphide of tin. Recovery of the tin content is said to be good. The complex concentrate from the flotation unit is being stores, whereas tin concentrate is shipped. The mill is situated close to the railroad.

■

Rand Has Not Yet Reached Peak, First Quarter Figures Show

Johannesburg, April 28. — The annual meetings of the leading Witwatersrand gold mines, held during the last week, indicate that the industry is in a very sound position and emphasize the fact that the world's leading gold field has not yet even reached the zenith of its prosperity. Continued improvement in the labor situation is reflected in production figures for the first quarter of 1930. Total production shows an increase of 32,094 oz. over the same period in 1929. This would indicate an output from the Rand this year of 10,100,000 oz., compared with the 9,980,713 oz. produced last year.

. . . . Official announcement has been made that an agreement has been reached between the Union government and the Union Steel Corporation, Ltd., whereby the former will acquire a controlling interest in the latter company. To accomplish this, the capital structure of the company is being altered. Iron and steel production from the Union appears assured.

. . . . Sinking of the Randfontein Deep shaft, on the Randfontein Estates property, in the western section of the Witwatersrand, has been resumed. This shaft, first sunk several years ago, was abandoned at a depth of 2,000 ft. Reopening of the working involved filling in an enormous cavity near the old shaft collar with concrete and then retimbering the entire distance. This work has been completed, and a 125-ft. steel headframe is being erected. A steam hoist has been installed for sinking work, but foundations are being excavated for an electrical hoist to be used when production is started. The shaft has seven compartments and will be continued to a depth of 4,500 ft., the elevation of the 30 level in the North Vertical section of the Randfontein holdings. Six Babcock & Wilcox steam boilers will furnish power for sinking operations. Two are already in service. Two No. 6 Sirocco fans will furnish ventilation. At present Randfontein Estates is hoisting from 120,000 to 140,000 tons of ore monthly through its North and South Vertical shafts. The Randfontein Deep shaft will take the place of No. 7 shaft, which caved recently.

■

Broken Hill Situation Serious; Mount Lyell Increases Output

Melbourne, April 26.—The British mine at Broken Hill, New South Wales, will close on June 30, the date of the expiration of the Board of Trade contract for zinc-concentrate purchases. At present about 450 men are employed at the property, which is operated by North Broken Hill and which has been producing about 500 tons of ore daily. Other mines in the Broken Hill district will also be seriously affected. Broken Hill Proprietary has already announced its intention of closing down its mine, which has been producing only for the last few months. Zinc Corporation, operating four leases and a 1,000-ton concentrator, will make drastic alterations in its mining practice in an endeavor to decrease mining costs so as to permit profitable operation when the contract expires.

. . . . Production of Mount Lyell, Australia's only important copper producer, continues to expand. For the quarter ended March 31, a total of 58,760 long tons of ore was mined, an increase of 3,400 long tons over the record for the previous quarter. Production was 2,710 long tons of copper, an increase of 600 tons; 52,044 oz. of silver, an increase of 8,480 oz.; and 1,151 oz. of gold, an increase of 400 oz. No drop in the rate of production is expected as a result of the decline in the price of copper.

. . . . Electrolytic Zinc again set a new record for production from its plant at

Risdon during the four weeks ended April 2. The total was 4,269 long tons, compared with the previous record of 4,251 tons made last January. Tin production from Tasmania should return to its old levels as the result of the discovery of a promising tin lode, 1 mile south of Renison Bell. Briseis Tin is reorganizing its capital structure to provide £65,000. This fund will be used for re-equipment of the company's flooded alluvial tin mine on the east coast of Tasmania.

. . . . The Australian federal government has been requested to provide £30,000 for an extensive exploratory program of the shallow copper lodes at Moonta, South Australia, which are now abandoned. The work done by the Imperial Geophysical Survey on behalf of the Australian government was unsatisfactory at Moonta because saline water interfered with accurate recording.

. . . . Consolidated Gold Fields of South Africa has provided the £250,000 necessary to equip the Bulolo Gold Dredging area, in New Guinea, on which two dredges will be installed. Airplanes will be used for this work. Another dredging venture in New Guinea is that of Guinea Gold, an Adelaide company, which has acquired an option on 1,000 acres of good dredging ground. New Guinea Gold Fields, the Mining Trust subsidiary, which promises to be the largest producer on the island, is now employing 100 white men and 900 natives in very satisfactory work on eight separate locations at its property. A practical motor tractor road has now been surveyed between the field and the coast. It will be 47½ miles long and will cost £68,000.

■

Large Gold Deposit Reported in Western Australia

Kalgoorlie, Western Australia, April 28.—A rich surface find has been made at Edjudina, on Lake Carey, 120 miles northeast of Kalgoorlie, that indicates the existence of a large gold deposit. An auriferous belt, 2 miles wide, has been traced, and gold is said to have been proved for 1,000 ft. on an outcrop, 10 ft. high, extending for a distance of 2,000 ft. Claims have been pegged along the belt for a distance of 5 miles. Many options have been exercised. Several prominent mining men have visited the field, and they have reported favorably on it. The general feeling is that it is the best gold discovery made in Western Australia in many years. Alfred Thomson, a prospector for Kimberley Oil, of Adelaide, made the discovery.

. . . . In February and March the new Golden Horseshoe tailing re-treatment plant handled 42,187 tons. From this a total of £8,232 in gold was recovered, at an estimated profit of £3,000. Estimates had indicated that the average assay of the tailing was 7s. 10d. a ton; that the average recovery would be about 3s. 11d. a ton, and that profits would be 1s. 5d. a ton. All of these estimates have been borne out by the first two months of operation, even though the plant did not attain its full capacity of 40,000 tons monthly. Reserves are sufficient for five years of operation at capacity.

. . . . A modern sampling plant has been completed at the Lake View & Star property to handle custom ore and ore from leasing operations. It will be able to handle 400 tons daily and will work in conjunction with the new flotation plant, of which the first unit is now almost completed.

. . . . The Golden Butterfly mine has been sold to Austral Development, a London company which has had the property under option for some time. The new company will take the property over in May. C. L. Baillieu and W. S. Robinson, who are interested in Broken Hill and other Australian base-metal companies, are directors.

. . . . Other news of gold mines that has developed within the last month includes a new strike at the Enterprise mine, from which assays as high as 94s. 6d. are reported; a good surface find at Ryansville, near Cue, in the Meekatharra district; and revival of interest in the Tanami field, in Central Australia.

■

Small Demand for Copper in Berlin Despite Lower Price

Berlin, April 30.—Despite the reduction in the price of copper, which is expected to result in a saving to German consumers of around $20,000,000, the demand for the metal here continues very small. Rumors of further cuts, originating in London, are undoubtedly the chief cause for the hesitancy of buyers. Aluminum producers are now uneasy about the future. They fear that cheaper copper will mean that substitution of their own metal will stop and that, with the falling off of demand for all metals in general, consumption of aluminum will be at a much lower rate. New reductions in the price of aluminum here are considered possible.

. . . . Mansfeld Copper, Germany's premier copper mine, is not doing so well as a result of the fall in the prices of both copper and silver. The miners have refused to agree to a reduction of 18 per cent in their wages. Mines de Bor, the Serbian copper producer, reports a production last year of about 19,000 metric tons of blister copper, which compares with production of 15,000 metric tons in 1928. The company has declared a dividend of 300 per cent.

. . . . Offers of scrap copper from the United States here are still very large. Metal consumption as a whole has probably dropped 40 per cent from last year's rate by now.

. . . . The zinc outlook is still judged unfavorable because of the large production of Canada, France, and Germany. None of these countries shows a decrease in output commensuate with the drop in price. Opposition by manufacturers to the proposals of German zinc producers for a tariff on the metal has been started. The zinc producers feel that Germany should be placed on a self-supporting basis in zinc, instead of having to import 50 per cent of its requirements. The manufacturers say that consumption will be affected by a duty, and that rollers, with annual requirements of 70,000 tons; brass manufacturers, who take about the same amount; galvanizers, 40,000 tons annually; and chemical industries, 20,000 tons, will not be able to meet competition in export markets if they have to pay more for their raw materials. Stolberg, which produces about 25,000 tons of zinc annually, has had to pass its dividend because of the low zinc price.

Dr. Cullen Believes Importance of Rhodesian Coppers Not Realized

London, April 28.—A statement has been made by Dr. William Cullen, the president of the Institution of Mining and Metallurgy, that most estimates understate the importance of developments in the Northern Rhodesian copper field. Dr. Cullen has just returned from the Third Triennial Empire Mining Congress, which visited many of the Northern Rhodesian mines. He believes that the most reliable estimates made to date are those of Prof. J. G. Lawn, made at the annual meeting of Johannesburg Consolidated Investment last December. Professor Lawn paid particular attention to the labor problems and estimated that not more than 8,000 colored workers would be needed for each 100,000 tons of copper produced annually. Generally, this estimate has been considered optimistic by financial writers interested in Rhodesian copper mines.

. . . . Roan Antelope, according to exclusive information, plans to treat ore from a part of its deposit that averages 3.75 per cent copper in its first 5,000-ton concentrator unit, now being built. A fifteen years' supply of this grade, which compares with the mine average of 3.3 per cent, is available. This news means that Roan's initial copper production is likely to be nearer 60,000 tons than 50,000 tons, the original estimate. Ore for the second 5,000-ton unit, to be built later, will probably be drawn from the Roan Extension section, where the average grade to date appears to be 4 per cent copper.

. . . . Official statement has now been made that plans for the N'Kana property of Bwana M'Kubwa are for a 10,000-ton concentrator. Together with the output from the company's Bwana unit, this indicates an annual production of 135,000 short tons, or almost as much as the potential capacity of Union Minière and not very much less than Utah or Chile Copper. Bwana's fire-refined copper output is now said to be averaging more than 99.9 per cent copper and is selling for a premium above "Best-Selected" on the London market.

. . . . The conference of copper men interested in the Rhodesian developments will probably get under way next week. Dr. Otto Sussman, president of American Metal, and Fred Searls, Jr., vice-president of Newmont Mining, are already in London. Other Americans expected include W. B. Congdon, who is a director of Calumet & Arizona, and E. T. Stannard, vice-president of Kennecott Copper. Important decisions with respect to the problems facing the Rhodesian mines are expected.

. . . . Another progress report has been issued on the Kansanshi property by Rhodesia-Katanga. It indicates that the limestone replacement deposits, averaging 7 to 14 per cent, are much larger than was expected. They occur in a dome-like hill that is the outstanding geological feature of the property. In addition, the sulphide reefs are opening up well. A great deal of work of importance is being done at this mine, and by the time Archer Wheeler, consulting metallurgical engineer of the company, visits it, the property may be in condition to permit preparation of plans for plant equipment.

MARKET AND FINANCIAL NEWS

Lead Production Shows Increase in March

World production of lead in March totaled 163,578 tons, against 147,725 tons in February, and 155,452 tons in January, according to the American Bureau of Metal Statistics. The daily rate of production for March was 5,277 tons, against 5,276 tons in the preceding month, and 5,015 tons in January. The daily rate for the whole of 1929 was 5,293 tons.

Production of lead in the United States, Peru, Germany, and Australia has increased since the first of the year. The only countries showing a decline are Spain and Italy. Production statistics, in tons, covering the first three months of the current year, follow:

	Jan.	Feb.	Mar.
United States (*a*)	48,308	51,362	57,625
Canada (*a*)	15,595	11,940	14,851
Mexico (*a*)	23,172	20,175	23,067
Peru	1,581	1,575	1,712
Germany	11,022	10,793	12,057
Italy	2,453	1,384	1,424
Poland	(*c*) 3,400	(*c*) 3,000	(*c*) 3,400
Spain and Tunis (*b*)	9,022	8,502	8,390
Australia	16,227	14,322	16,380
Burma	7,672	7,672	7,672
Elsewhere (*c*)	17,000	17,000	17,000
World's total	155,452	147,725	163,578
United States	48,308	51,362	57,625
Rest of world	107,144	96,363	105,953

(*c*) Total North American production of crude lead correctly stated, but the distribution by countries not precise. (*b*) Partial. (*c*) Estimated.

World's lead production by months, and the daily rate by months, for 1929 and the first three months of this year, in tons, follow:

1929	Total	Daily Rate
January	156,155	5,037
February	141,895	5,068
March	160,450	5,176
April	162,545	5,418
May	168,631	5,440
June	164,002	5,467
July	163,594	5,277
August	161,207	5,200
September	159,018	5,301
October	170,306	5,494
November	163,904	5,463
December	160,223	5,168
1930		
January	155,452	5,015
February	147,725	5,276
March	163,578	5,277

Monthly average production for 1929 was 160,994 tons. The monthly average for the first quarter of 1930 was 155,585 tons.

■

Patiño Profit Down in 1929

Profit of Patiño Mines & Enterprises, world's premier tin producer, dropped from $5,224,227 in 1928 to $4,573,239 in 1929, as a result of the lower average price of tin. Production increased from 17,016 long tons in 1928 to 20,926 long tons in 1929. The cost of production was virtually unchanged at 29.2c. a pound. Surplus on Dec. 31 was $1,023,678, as compared with $2,600,185 in the preceding year, but the company's depletion and depreciation reserve had increased from $2,595,530 to $3,324,617. The company has $1,579,783 in cash in banks.

■

St. Joe Lead's Net Income Increased by Two-thirds

Net income of St. Joseph Lead, operating properties in Missouri, and subsidiary companies, was $7,537,155 in 1929, a gain of about 67 per cent over the income of $4,533,263 in 1928. This income is after deduction of all charges, including taxes, depreciation, and depletion. The surplus on Dec. 31, 1929, was $14,857,453, compared with $13,493,586 at the end of 1928. Current assets at the end of 1929 were $10,360,614, and current liabilities, including dividends payable in 1930, were $8,320,525. The company has investments of $1,961,183.

Lead content of concentrates produced in 1929 was 178,181 tons, compared with 148,568 tons in 1928. Zinc content of concentrates produced was 35,115 tons, compared with 27,361 in 1928.

■

CONIAURUM MINES, operating in the Porcupine district, Ontario, made an operating profit of $25,075 in 1929. Production was 103,293 tons of ore, with recovery averaging $6.453 a ton. The company has a surplus of $252,658 of current assets over current liabilities.

Kennecott's Profits in 1929 Exceeded $50,000,000

Net income of Kennecott Copper Corporation and its subsidiaries, after deductions for taxes and depreciation, was $52,066,365 in 1929, compared with $45,651,533 in 1928. Total operating revenue was $116,128,840. Production of copper at Braden, in Chile, was 83,163 tons and at the Alaskan mines was 15,278 tons. Including the output of Utah Copper, in which the company holds about 98 per cent of the outstanding stock, production was 250,567 tons, compared with 260,049 tons in 1928.

At the end of 1929, the company's earned surplus was $131,939,919, compared with $122,388,743 in 1928. Assets were put at $337,807,866 in 1929, of which $205,482,622 represented properties. In 1928, assets were $298,761,676, of which $187,450,718 represented properties. Current assets at the end of the year were $89,412,506, compared with $72,600,720 at the end of 1928. Current liabilities were $5,466,370 and $4,399,378 in 1929 and 1928, respectively.

In June, 1929, the entire outstanding capital stock of the Chase Companies, Inc., was acquired by Kennecott by the payment of 253,125 shares of Kennecott stock. Total stock outstanding at the close of the year was 9,385,849 shares.

■

ROYAL DEVELOPMENT, operating a copper property near Leavenworth, Wash., had a paid-in surplus of $474,635 at the end of 1929. Cash on hand was $179,176.

To Users of *E. & M. J.* Market Prices and Data

THE semi-monthly *Engineering and Mining Journal* (which you are now reading) carries only a condensed review of important market news and price movements. For buyers and sellers of ores, metals, and minerals who require the latest information every week, we now publish every Wednesday night a weekly—*Metal and Mineral Markets*. Printed at high speed, and in a new compact form for reference use, this new service has received enthusiastic indorsement from readers not requiring the technical contents and field operating news carried in the magazine. *Metal and Mineral Markets* is priced to subscribers in the United States and possessions at $2 yearly; to countries in the Americas, but outside the United States, $5; elsewhere, $10 per annum.

Anaconda Copper Earned $69,115,728 in 1929

The annual report of the Anaconda Copper Mining Company and subsidiaries, including Andes Copper, Chile, and Greene Cananea, showed a net income for 1929 of $69,115,728 after deducting all taxes, depreciation, the proportion accruing to minority interests, and charging off $4,080,866 in discount and interest on bonds redeemed on Aug. 1, 1929. Net earnings in 1928 were $24,174,780. Earnings for last year were equal to $7.83 a share on 8,828,063 shares outstanding, and compare with $6.63 a share on 3,648,311 shares in 1928.

The consolidated income account for 1929 and the preceding year follows:

	1929	1928
Gross	$305,751,876	$291,199,087
Costs, operating expenses, taxes	223,972,464	265,092,858
Operating profit	$81,779,412	$26,106,229
Other income	8,483,040	13,734,958
Total income	$90,262,452	$39,841,187
Depreciation	11,685,736	5,296,438
Interest	(a) 8,258,977	10,359,605
Minority interest	1,202,010	10,364
Net income	$69,115,729	$24,174,780

(a) Includ ed $4,080,867 discount and interest on bon ds redeemed.

Total assets on the balance sheet for Dec. 31, 1929, were $764,227,815, against $505,683,143 in 1928. Metals and manufactured products were carried at cost, less reserve. In 1929 the company acquired all but a small minority of the outstanding stock of Chile, Andes, and Greene Cananea.

During the year Anaconda discharged funded indebtedness of $134,477,000, consisting of $16,933,000 ten-year Series A 6 per cent secured gold bonds, due Jan. 2, 1929, for which payment was made from current cash; $104,401,000 first consolidated Series A 6 per cent sinking fund gold bonds, due 1953, and $13,143,000 fifteen-year 7 per cent convertible debentures, due 1938. Funds for redemption of these bonds and the unconverted portion of the debentures were secured by issuance to stockholders April 30, 1929, of rights to buy two shares at $55 per share for each five shares owned at that time.

The only funded indebtedness remaining on Dec. 31, 1929, was $2,182,000 first mortgage 5 per cent sinking fund gold bonds of the Butte, Anaconda & Pacific Railway Company, due 1944, and $35,000,000 5 per cent gold debentures of the Chile Copper Company, due 1947.

Outstanding bonds of Silesian-American Corporation were reduced to $11,512,000 at Dec. 31, 1929. Principal production for the year of the Polish subsidiary was: Zinc, 153,946,000 lb.; lead, 14,559,000 lb.; coal, 3,208,000 metric tons; sulphuric acid, 121,060 metric tons; and superphosphate, 71,880 metric tons. During the year $1,410,506 was expended for plant construction.

Production of copper by Anaconda and its subsidiaries for the last two years, in pounds, follows:

	1929	1928
Anaconda	297,014,107	247,577,554
Andes	162,663,775	104,057,471
Chile	299,575,752	265,863,517
Greene Cananea	58,826,951	36,420,009
International Smelting	172,488,878	142,400,574
Total	990,569,463	(a)

(a) As all of the companies listed were not completely controlled by Anaconda in 1928, the total is omitted.

Production of silver in 1929 by Anaconda and its subsidiaries was 11,384,776 oz. from copper operations. Output of gold was 106,420 oz.

Electrolytic zinc produced during the year at the Anaconda and Great Falls plants amounted to 273,357,416 lb., against 321,122,464 lb. in 1928.

The International Smelting Company produced from custom ores, in addition to the copper listed in the table, 152,536,672 lb. of lead, 6,356,611 oz. of silver, and 38,163 oz. of gold.

Miscellaneous production included 19,714 tons of treble superphosphate and phosphoric acid, 10,628 tons of arsenic, 57,619,579 lb. of zinc oxide, 17,831,740 lb. of white lead, 802,753 lb. of cadmium, 379,100 lb. of nickel sulphate, and 800,493 lb. of copper sulphate.

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Treadwell Yukon Deficit

Operations of Treadwell Yukon, with interests in Ontario, Yukon, Nevada, Idaho, and Alaska, showed a deficit for 1929, after all charges, of $297,362, compared with a net profit in 1928 of $12,996. Increased development work is responsible for the decrease in earnings. The total deficit at the end of the year was $608,972. Operation of the company's Wernecke mines, in Yukon, showed a net profit, after all charges, of $380,255 in 1929, compared with $328,564 in 1928. Operations of the Tybo mines, in Nevada, showed a net loss of $139,517, but an operating profit of $2,740. Last year was the first year of production at Tybo. At the close of the year the company's principal outstanding debts were $3,257,574 to Bunker Hill & Sullivan, $2,720,670 to Alaska Treadwell, and $660,981 to Alaska Mexican Gold. The amount owed Bunker Hill was almost doubled.

■

Ohio Copper, operating a property at Bingham Canyon, Utah, showed a loss of $41,030 after all charges in 1929, compared with a loss of $35,625 in 1928. At the end of the year the company's deficit was $229,147. Outstanding convertible bonds were reduced to $179,300 at the end of the year, compared with $278,700. The company has cash on hand of $350,767. Copper production was 2,215,178 lb. of copper in 1929, compared with 3,973,282 lb. in 1928.

Metallgesellschaft Earned 6,080,961 Marks

The Metallgesellschaft, Frankfurt a/M, Germany, reports for the year ended Sept. 30, 1929, a gross income of 22,623,191 marks. Net income for the fiscal year, after deducting operating expenses, taxes, interest, and amortization, was 6,080,961 marks, according to the report made to stockholders at the annual meeting held early in January of the current year. A dividend of 8 per cent was declared on the common stock, 6 per cent on preferred stock Series 1, and 7½ per cent on preferred stock Series 2. Common stock outstanding is valued at 55,000,000 marks, preferred stock Series 1, 1,860,000 marks, and Series 2, 2,400,000 marks. Bonus payments and funds set aside during the year for the aid of employees amounted to 827,677 marks. A total of 441,683 marks was carried over to the next fiscal year.

Important company developments in 1929 included construction of a Waelz plant in Duisburg for treatment of tin ore, and the extension of the aluminum plant in Bitterfeld, owned jointly with I.G. Farbenindustrie. Progress was made during the year in the introduction of the Lurgi coal-distillation process, new plants being under construction in the United States, Canada, and New Zealand. Extension of research laboratories absorbed 1,540,000 marks during the year.

■

Financial Notes

Goldfield Consolidated Mines, now largely a holding company, had total assets of $4,834,371 at the end of 1929. The only liability was the outstanding capital stock of 3,859,148 shares.

Mayflower-Old Colony Copper, developing a property in the upper peninsula of Michigan, reports cash on hand of $3,991 at the end of 1929. The company spent $54,950 in development work during the year. Revenue from assessments and miscellaneous sources totaled $50,998.

Aldermac Mines, developing a copper-pyrites property in the Rouyn district, Quebec, reports assets of $1,203,885 at the end of 1928. Current liabilities are $86,208, of which $73,594 represents a loan from Noranda Mines. The only other liability is the outstanding capital stock.

Base Metals Mining, operating a lead-zinc property at Field, B. C., had cash on hand amounting to $2,322 at the end of 1929; accounts receivable, $1,318; and concentrate in transit valued at $34,776. Its principal liabilities were loans of $179,497 and accounts payable of $32,541. The company started producing in November, 1929.

Zinc Output at High Rate Despite Low Prices

INTERNATIONAL METAL SERVICE, LTD., LONDON

Despite the fact that the selling price of zinc is well below its intrinsic value, no curtailment of output is apparent. For some time the main hope in this direction has rested more with the mining branch of the industry, and it is indeed difficult to discover any inducement for many of the producers to carry on. However, so far, although there have been many and repeated reports of mines having decided that to shut down represents the lesser of the two evils with which they are faced, there does not seem to be any substantial diminution in the flow of supplies to smelters. The tonnages available are in excess of needs, and the industry is confronted with the fact that smelters have been able to hold their returning charges at almost the same figure as when metal was selling at a considerably higher level. In other words, the brunt of the trouble is falling on the shoulders of the mining interests, and the custom smelters are not feeling the pinch to anything like the same extent, and are not nearly as willing to consider the question of putting their house in order as they would be if their returning charges had been substantially cut down. These comments, of course, apply only to the European situation.

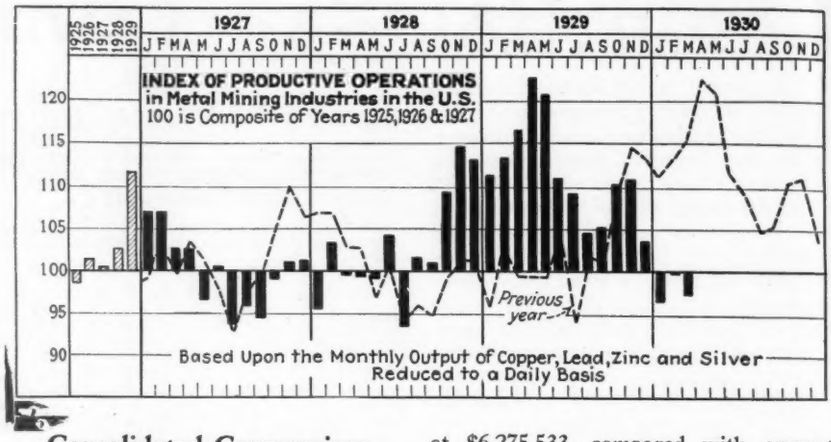
The prospects of any workable scheme for regulation of output have not been rendered any brighter as a result of the decision reached at a meeting of German producers held toward the end of March. The German smelters make it plain that in any international arrangement they will be unable to accede to any demand for curtailment of production. The German interests point out that their country is a large importer of zinc.

As far as consumption goes, the tale is practically the same throughout the world; demand is not equal to taking care of all the tonnages available, let alone making any serious inroads into the accumulations of metal on the hands of smelters.

Naturally, until production falls, traders will continue to take a despondent view of the outlook. Consumers hold that there is no reason for them to do more than cover their near-by needs. The price movement depends on the ability of producers to restrict offerings.

World stocks of zinc on April 1 follow:

	Metric Tons
United States	85,000
Canada, including afloat	4,000
Germany-Poland	18,700
Belgium	11,600
France	2,500
Great Britain	5,900
Other Europe	3,200
Australia, including afloat	4,000
Far East	1,500
Elsewhere	2,000
Total	138,400



Consolidated Coppermines

During 1929, Consolidated Coppermines spent $473,172 on completion of its plant construction program at Ely, Nev. Mine development work accounted for an expenditure of $1,233,163, according to H. D. Smith, president of the company, in the annual report. Of the total of $1,706,335 spent on property account, $75,000 was raised by stock sales and the remainder was provided by profits from mine operation and from current assets. At the end of 1929, the company had current assets of $1,489,951, compared with current assets of $2,015,864 at the end of 1928. Total assets were $13,674,299, compared with $13,136,440 at the end of 1928. In 1929, the company produced 22,731,703 lb. of copper. Production for the first two months of 1930, during which an operating profit of $300,000 was made, was 6,604,042 lb. of copper.

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Hudson Bay M. & S.

At the end of 1929, Hudson Bay Mining & Smelting had current assets of $4,495,661, compared with $12,918,109 at the end of 1928. The shrinkage is represented entirely by expenditures on the company's copper-zinc property near The Pas, Manitoba. Investments other than those entered under current assets were valued at $2,969,856 at the close of 1929, compared with $2,988,323 the previous year. Additional financing to the extent of $2,000,000 or $2,500,000 will be necessary, according to announcement made at the company's annual meeting. What form this will take is not known.

■

Magma Made Large Gain

Magma Copper, operating a property at Superior, Ariz., made a net profit of $3,004,765 in 1929, after all charges except depletion. In 1928, the profit was $1,952,495. At the end of the year the company's balance was $1,599,685, compared with $792,332 at the end of 1928. Total current assets are put at $6,275,533, compared with current liabilities of $1,198,761. Production in 1929 was 38,235,310 lb. of copper, 1,158,735 oz. of silver, and 13,405 oz. of gold, including metal from custom ore treated at the smelter. Cost per pound of copper produced was 9.987c., compared with 9.227c. per pound in 1928.

■

Financial Notes

TEXAS GULF SULPHUR reports a net income of $3,803,701 in the first quarter of 1929.

TONOPAH BELMONT DEVELOPMENT, operating properties in Nevada, showed a deficit of $4,928 in the balance sheet at the end of 1929. The company has available assets of $154,459. All work has been permanently suspended at the Belmont MacNeill mine, in Arizona.

MEXICAN PREMIER, operating in Mazatlan, Mexico, made an operating profit of $193,402 from a gross income of $521,338 in 1929. Production was 46,495 tons of ore, from which 979,387 oz. of silver, 1,810 oz. of gold, 3,653,723 lb. of lead and 15,422 lb. of copper were obtained.

BUENA TIERRA MINING, operating in Chihuahua, Mexico, made a net profit of £1,720 in 1929, reducing the company's debt to £77,079. Production was 10,198 tons of ore, averaging 10 per cent lead and 14 oz. of silver to the ton. Output will be increased considerably in 1930.

MOTHER LODE COALITION, operating a copper property in Alaska, reports net operating profit, after taxes, of $692,599 in 1929, compared with $1,036,849 in 1928. Only 8,343,624 lb. of copper was sold during the year, compared with 17,900,850 in the preceding year, and the value of copper on hand, at cost, amounted to $378,933 at the end of 1929, compared with $42,445 at the end of 1928. The company's surplus, after deduction of all liabilities except capital, was $2,076,463 at the end of 1929, compared with $2,896,030 at the end of 1928.

Average Metal Prices for April, 1930

COPPER:	
Electrolytic, refinery	15.621
London Standard Spot	62.075
London Electrolytic Spot	74.338
LEAD:	
New York	5.537
St. Louis	5.428
London Spot	18.319
London Forward	18.363
SILVER:	
New York	42.428
London	19.554
Sterling Exchange	486.019
ZINC:	
St. Louis	4.843
London Spot	17.819
London Forward	18.378
TIN:	
Straits	36.077
London Standard Spot	162.638
QUICKSILVER	114.000
ANTIMONY	7.740
PLATINUM:	
Refined	46.462
Crude	38.462
ALUMINUM 99 Per Cent Plus	24.300

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Financial Notes

DOME MINES, operating a gold property in Ontario, reports a net profit of $89,687 in the first quarter of 1930. Destruction of the company's mill has cut the operating income.

BUTTE COPPER & ZINC reports a net loss of $18,953 in the first quarter of 1930, compared with net profit of $44,739 in the first quarter of 1929.

AMERICAN ZINC, LEAD & SMELTING reports a net profit of $226,332 in the first quarter of 1930, compared with $314,908 in the first quarter of 1929.

HOWE SOUND reports a net profit of $723,030 in the first quarter of 1930, compared with $990,285 in the first quarter of 1929.

AMPARO MINING, operating a silver-gold property in Jalisco, Mexico, reports a loss in 1929 of $84,993, compared with a loss of $88,912 in 1928. Net assets of the company at the close of the year, after deduction of all liabilities, were $2,336,679, compared with $2,489,527 at the end of 1928. Available assets were $783,080, compared with $938,007.

ST. JOHN DEL REY MINING, operating the Morro Velho gold mine, in Brazil, reports an operating profit of £114,638 in 1929, compared with £98,758 in 1928. Value of bullion produced was £466,690, compared with £419,090. At the end of the year the company's balance was £90,586, compared with £88,513 at the end of 1928. Value of the company's investments at the end of the year was £180,782, compared with £200,183 at the end of 1928.

Price Uncertainty Restricts Business in Major Non-Ferrous Metals

New York, April 30, 1930.—Uncertainty in regard to the price structure restricted trading in the major non-ferrous metals to a minimum. Rumors of an impending reduction in copper to 12c. had a depressing influence on virtually all branches of the industry. Lead held on the basis of 5.50c., New York, throughout the period, but sales were well below the average in volume. Zinc made a new low for the movement. Heavy shipments of tin brought out renewed selling pressure in London and the market broke rather sharply. Quicksilver was offered freely at easier prices. Trading in antimony was extremely quiet and spot material was available at times at slight concessions from the import parity. Cadmium held at 70c. for ton lots.

Copper Dull at 14c.

The decline to the 14c. basis has not resulted in any expansion in domestic business in copper. The spurt in export buying which set in immediately after the reduction was announced proved to be short-lived. With general industrial activity still subnormal and an almost daily crop of rumors of an impending reduction in the price—12c. being the figure generally named—sales actually fell off during the last fortnight. The tendency of the market toward the close was very uncertain, yet no action was taken by producers in the matter of restoring confidence in the situation. Stocks of refined copper are expected to show another increase for the month of April, and, unless consumptive requirements improve appreciably in the near future, trade authorities believe that something will have to be done to bring about a further reduction in production. Export sales for April amounted to about 43,500 long tons, against 34,600 tons in March, and 33,000 tons in February.

Lead Sales Off

Business in lead was at a reduced rate in the last two weeks. This was attributed to a somewhat overbought condition, for consumers purchased lead rather freely on the scale-down in March, and unsettlement in the London market. No price change was announced by the leading interest in New York, the quotation holding at 5.50c. In St. Louis prices varied slightly according to seller, the range at the close being 5.35 to 5.40c. Present prices are expected to discourage production, and producers are not disposed to name lower figures unless forced to do so by further weakness in London.

Zinc Continues Easy

With production in excess of requirements, the trend of prices for zinc again was downward, Prime Western selling at 4.70c., East St. Louis, a new low for the movement and the lowest since 1922. Production is being curtailed in more than one direction, but the quiet prevailing in both the galvanizing and brass industries has more than offset this development as a factor in the present situation. Production of zinc for all countries, except Belgium and Poland, during March totaled 105,313 tons, against 96,641 tons in February, and 105,187 tons in January of the current year.

Tin Under Pressure

Selling pressure abroad, induced by news of heavy shipments from primary centers and a disappointing demand, forced tin prices to the lowest point in eight years. In spite of the curtailment policy of producers, the statistical position of the market is going from bad to worse. The so-called world's visible supply at the end of April showed a gain for the month of more than 3,500 tons. Compared with the figures of a year ago, the visible supply has increased slightly more than 10,000 tons. On the last day of the month Straits tin for prompt shipment sold as low as 33¾c. Deliveries of tin in the United States during April totaled 6,780 tons, against 8,675 tons in the preceding month, and 8,435 tons in April, 1929.

Silver Steady

The market for silver was a featureless affair, prices in New York ranging from 42⅜ to 42⅞c., and closing at the inside figure. Steadiness in Chinese exchanges and a moderate demand from India resulted in an almost stationary price.

Other Metals

Quotations cover large wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM — Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.; 98-99 per cent, 23.90c. London, 98 per cent, quoted at £95 per long ton, less 2 per cent, for ingots and bars.

ANTIMONY—Per lb., duty paid: Chinese brands, spot, 7½@7⅝c.; futures, 5⅝c. in bond. Cookson's "C" grade spot, 12⅞c.

BISMUTH—Per lb., in ton lots, $1.20. Smaller lots, $1.35 and up. London 5s. for round lots.

CADMIUM—Per lb., 70c. for ton lots. London, 3s. 11d.@4s. for prompt.

CHROMIUM—Per lb., 97@98 per cent grade, 95c.@$1.

Daily Prices of Metals

April	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
17	13.775	36.50	5.50	5.40	4.80
18	13.775	36.50	5.50	5.40	4.80
19	13.775	36.375	5.50	5.40	4.80
21	13.775	36.375	5.50	5.40	4.75
22	13.775	35.75	5.50	5.40	4.75
23	13.775	35.625	5.50	5.40	4.75
Av'ge	13.775	36.188	5.500	5.400	4 775
24	13.775	35.375	5.50	5.40	4.75
25	13.775	35.000	5.50	5.35@5.40	4.725@4.75
26	13.775	34.875	5.50	5.40	4.725@4.75
28	13.775	34.750	5.50	5.40	4.725@4.75
29	13.775	34.375	5.50	5.40	4.70
30	13.775	33.875	5.50	5.35	4.70
Av'ge	13.775	34.708	5.500	5.388	4.727

Average prices for calendar week ended April 19, 1930, are: Copper, 14.442c.; Straits tin, 36.438c.; New York lead, 5.500c.; St. Louis lead, 5.400c.; zinc, 4.829c.; and silver, 42.542c.

Average prices for calendar week ended April 26, 1930, are: Copper, 13.775c.; Straits tin, 35.500c.; New York lead, 5.500c.; St. Louis lead, 5.396c.; zinc, 4.746c.; and silver, 42.646c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms or wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

April	Sterling Exchange "Checks"	Silver		Gold London	April	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
17	4.85 3/4	42 5/8	19 11/16	84s10 1/4d	24	4.86	42 1/2	19 5/8	84s10 3/4d
18	4.85 7/8	42 1/2	Holiday	Holiday	25	4.86	42 5/8	19 11/16	84s11 1/2d
19	4.85 3/4	42 1/2	Holiday	Holiday	26	4.85 15/16	42 1/2	19 11/16	.....
21	4.85 7/8	42 1/2	Holiday	Holiday	28	4.85 3/4	42 1/2	19 11/16	84s11 1/2d
22	4.85 3/4	42 7/8	19 3/4	84s11 1/4d	29	4.86	42 1/2	19 11/16	84s11 1/2d
23	4.85 7/8	42 7/8	19 13/16	84s11 1/2d	30	4.86	42 3/8	19 5/8	84s11 1/4d

Average for week ended April 23: Silver, 42.646c.; Sterling Exchange, $4.85813.

Average for week ended April 30: Silver, 42.500c.; Sterling Exchange, $4.85948.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-quarter cent premium.

London

April	Copper Standard		Electrolytic Spot	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3 M	Spot	3 M
17	58 7/8	58 13/16	65	165	167 1/4	18 5/16	18 3/8	17 13/16	18 5/16
18	Holiday	.....	.....	.....	.....	.....	.....	.....	.....
21	Holiday	.....	.....	.....	.....	.....	.....	.....	.....
22	55 3/8	55	65	162 1/2	164 1/2	18 1/16	18 1/8	17 1/2	18 1/16
23	54 1/4	54 1/2	64	160 5/8	162 7/8	17 3/4	17 13/16	17 5/16	17 5/8
24	54	53 3/8	64	160 1/2	162 5/8	18	17 7/8	17 1/4	17 3/4
25	52 3/8	52	64	159 1/8	161 1/4	18	17 7/8	17 5/16	17 7/8
28	52 1/2	52 1/4	62	157 1/8	159 3/4	17 15/16	17 3/4	17 1/8	17 11/16
29	52	51 3/4	62	156 1/2	158 3/4	17 3/4	17 5/8	17	17 1/2
30	50 3/8	49 3/4	62	153	155	17 3/4	17 11/16	16 7/8	17 3/8

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

COBALT—Per lb., f.o.b. Canadian works: Shot or rondelles, 97@98 per cent, $2.50. Contract sales booked at discounts, depending on quantity. Black oxide, 70 per cent, $2.10. London, nominal, 10s. for metal in small lots, 8s. for black oxide; 8s. 10d. for gray.

IRIDIUM—Per oz., $150@$155 for 98 @99 per cent sponge and powder. London, £30@£32.

NICKEL—Per lb., ingot, 35c.; shot, 36c.; electrolytic, 35c. (99 per cent), for single lots of spot metal. London, per long ton, £170@£175.

PALLADIUM—Per oz., $26@$28. London, £5 5s.

PLATINUM—Official price quoted by the leading interest on small orders for the refined metal, per troy oz., $46. Transactions between dealers and refiners in the outside market are commonly reported at several dollars less. London quotes £9 5s.@£9 15s.

QUICKSILVER—Per 76-lb. flask, $112@ $114; nominal. The official price of the Italian-Spanish cartel is £21 15s., f.o.b. shipping point. London quiet, with spot quoted at £22 15s. per flask.

SELENIUM—Per lb. in 500-lb. lots: Black, powdered, amorphous, 99.5 per cent pure, $1.95@$2. London, 7s. 8d.@ 7s. 9d.

TANTALUM—Per kilo.: Sheet, chemically pure, $128; tantalum powder, $69.35.

Metallic Ores

ANTIMONY ORE—Bolivian ore, 60 per cent metallic antimony, $1.30 per short ton unit, c.i.f. New York.

CHROME ORE—Per long ton, f.o.b. Eastern shipping points, Indian and Rhodesian ores, $21.50 for 46@47 per cent Cr_2O_3 ore, and $24 for 50@51 per cent ore. New Caledonian ore, high-grade, $25.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports in cargo lots, exclusive of duty: Brazilian and Indian ores, minimum 47 per cent Mn, 29@30c.; Caucasian, 52@55 per cent, 30@32c.; Cuban, minimum 47 per cent, 32c.; Chilean, minimum 47 per cent, 34c.

TUNGSTEN ORE—Per short ton unit of WO_3, N. Y.: Wolframite, $14 for future delivery. Bolivian scheelite is quoted at $14.50, May-June shipment. Western scheelite, $16.50, forward delivery.

■

Lead and Zinc Concentrate

Joplin, Mo., April 26, 1930

Blende	Per Ton
High	$37.30
Prime Western, basis 60%	35.00
Table and flotation, 60%	34.00
Average settling price, all	35.32
Galena	
High	$66.70
Basis 80% lead	62.50
Average settling price, all	64.64

METAL STATISTICS

Monthly Average Prices of Metals

Silver

	New York		London Spot		Sterling Exchange	
	1929	1930	1929	1930	1929	1930
January	57.019	45.000	26.257	20.896	484.577	486.447
February	56.210	43.193	25.904	20.008	484.787	485.784
March	56 346	41.654	26.000	19.298	484.776	485.933
April	55.668	42.428	25.738	19.554	484.808	486.019
May	54.125	.....	25.084	.....	484.599	.....
June	52.415	.....	24.258	.....	484.330	.....
July	52.510	.....	24.289	.....	484.560	.....
August	52.579	.....	24.288	.....	484.368	.....
September	51.042	.....	23.708	.....	484.253	.....
October	49.913	.....	23.042	.....	486.392	.....
November	49.615	.....	22 690	.....	487.104	.....
December	48.475	.....	22.258	.....	487.523	.....
Year	52.993	.....	24.460	.....	485.173	.....

New York quotations, cents per ounce troy, 999 fine. London, pence per ounce, sterling silver, 925 fine. Sterling exchange in cents.

Copper

	F.O.B. Refinery	London Spot			
	Electrolytic	Standard		Electrolytic	
	1929	1930	1929	1930	1929	1930
January	16.603	17.775	75.551	71.469	78.602	83.250
February	17.727	17.775	78.228	71.419	83.538	83.500
March	21.257	17.775	89.153	69.202	98.356	83.405
April	19.500	15.621	81.036	62.075	89.405	74.338
May	17.775	.....	75.026	.....	83.727	.....
June	17.775	.....	74.338	.....	84.013	.....
July	17.775	.....	72.152	.....	84.043	.....
August	17.775	.....	73.783	.....	84.250	.....
September	17.775	.....	75.286	.....	84.363	.....
October	17.775	.....	72 815	.....	83.978	.....
November	17.775	.....	69.324	.....	82.202	.....
December	17.775	.....	68.303	.....	82.569	.....
Year	18.107	.....	75.416	.....	84.921	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Lead

	New York		St. Louis		London			
	1929	1930	1929	1930	1929 Spot	1929 3 Mos.	1930 Spot	1930 3 Mos.
January	6.650	6.250	6.498	6.100	22.111	22.344	21.545	21.571
February	6.853	6.236	6.739	6.086	23.128	23.156	21.188	21.097
March	7.450	5.662	7.348	5.542	25.409	25.591	18.807	18.940
April	7.187	5.537	7.025	5.428	24.783	24.408	18.319	18.363
May	7.000	.....	6.761	.....	23.949	23.750	.....	.....
June	7.000	.....	6.790	.....	23.694	23.603	.....	.....
July	6.804	.....	6.607	.....	22.810	22.880	.....	.....
August	6.750	.....	6.553	.....	23.185	23.259	.....	.....
September	6 890	.....	6.689	.....	23.557	23.589	.....	.....
October	6 873	.....	6.674	.....	23.226	23.253	.....	.....
November	6.285	.....	6.135	.....	21.622	21.643	.....	.....
December	6.250	.....	6.100	.....	21.472	21.484	.....	.....
Year	6.833	.....	6.660	.....	23.246	23.247	.....	.....

New York and St. Louis quotations, cents per pound. London, pounds sterling per long ton.

Tin

	New York		London	
	1929	1930	1929	1930
	Straits		Spot	
January	49.139	38.851	222.727	175.466
February	49.347	38.676	223.138	173.750
March	48.870	36.798	220.781	164.851
April	45.858	36.077	206.887	162.638
May	43.904	.....	197.545	.....
June	44.240	.....	200.206	.....
July	46.281	.....	209.473	.....
August	46.619	.....	209.815	.....
September	45.359	.....	204.863	.....
October	42.290	.....	190.783	.....
November	40.208	.....	180.565	.....
December	39.745	.....	179.419	.....
Year	45.155	.....	203.850	.....

New York quotations, cents per pound. London, pounds sterling per long ton.

Zinc

	St. Louis		London			
	1929	1930	1929 Spot	1929 3 Mos.	1930 Spot	1930 3 Mos.
January	6.350	5.229	26.196	26.233	19.634	20.241
February	6.350	5.180	26.247	26.347	19.209	19.278
March	6.463	4.934	27.050	27.294	18.304	18.810
April	6.658	4.843	26.759	26.613	17.819	18.378
May	6.618	.....	26.727	26.619	.....	.....
June	6.686	.....	26.216	25.984	.....	.....
July	6.766	.....	25.332	25.418	.....	.....
August	6.800	.....	24.896	25.164	.....	.....
September	6.799	.....	24.208	24.688	.....	.....
October	6.740	.....	22.927	23.329	.....	.....
November	6.242	.....	20.851	21.351	.....	.....
December	5.666	.....	20.072	20.672	.....	.....
Year	6.512	.....	24.790	24.976	.....	.....

St. Louis quotations, cents per pound. London pounds sterling per long ton.

Antimony, Quicksilver, and Platinum

	Antimony (a) New York		Quicksilver (b) New York		Platinum (c) Refined New York		Platinum (c) Crude New York	
	1929	1930	1929	1930	1929	1930	1929	1930
Jan	9.558	8.606	119.481	121.192	70.000	61.923	60.000	51.923
Feb	9.548	8 830	119.818	120.500	70.000	59.909	60.000	51.909
March	9.531	8.236	121.904	118 808	70.000	54.769	60.000	46.769
April	9.462	7.740	122.000	114.000	70.000	46.462	60.000	38.462
May	8.957	. . .	121.154	. . .	68.615	. . .	58.615	. . .
June	8.845	. . .	120.500	. . .	68.000	. . .	58.000	. . .
July	8.543	. . .	121.654	. . .	68.000	. . .	58.000	. . .
Aug	8.778	. . .	125.111	. . .	68.000	. . .	58.000	. . .
Sept	8 709	. . .	124.542	. . .	66.000	. . .	56.000	. . .
Oct	8.538	. . .	124.298	. . .	65.000	. . .	55.000	. . .
Nov	8.583	. . .	123.323	. . .	65.000	. . .	55.000	. . .
Dec	8.420	. . .	121.950	.....	63.240	. . .	53.240	. . .
Year	8.956	. . .	122.145	.....	67.655	. . .	57.655	. . .

(a) Antimony quotations in cents per pound, for ordinary brands. (b) Quicksilver in dollars per flask of 76 lb. (c) Platinum in dollars per ounce. Price of crude based on refined platinum content.

Pig Iron[1] and Aluminum

	Bessemer		Basic		No. 2 Foundry		Aluminum	
	1929	1930	1929	1930	1929	1930	1929	1930
Jan	18.00	19.00	17.50	18.50	17.50	18.50	24.300	24.300
Feb	18.00	19.00	17.50	18.50	17.50	18.50	24.300	24.300
March	18.19	19.00	17.62	18.50	17.69	18.50	24.300	24.300
April	18.50	19 00	18.00	18.50	18.00	18.50	24.300	24.300
May	18.81	. . .	18.31	.....	18.31	.....	24.300	.....
June	19.00	. . .	18.50	. . .	18.50	.....	24.300	. . .
July	19.00	. . .	18.50	. . .	18.50	. . .	24.300	. . .
Aug	19.00	. . .	18.50	. . .	18.50	. . .	24.300	.....
Sept	19.00	. . .	18.50	.....	18.50	. . .	24.300	.....
Oct	19 00	.....	18.50	.....	18.50	. . .	24.300	. . .
Nov	19.00	. . .	18.50	. . .	18.50	. . .	24.300	. . .
Dec	19.00	.....	18.50	.....	18.50	.....	24.300	.....
Year	18.71	. . .	18.20	.....	18.21	. . .	24.300	.....

Iron in dollars per long ton. Aluminum in cents per pound, 99 per cent grade.

[1]F.o.b. Mahoning and Shenango valley furnaces; freight to Pittsburgh, $1.76.

Monthly Crude Copper Output in Short Tons

Domestic

	1929 Total	1929 Nov.	1929 Dec.	1930 Jan.	1930 Feb.	1930 Mar.
Alaska shipments	21,947	2,079	2,275	1,219	1,298	2,109
Calumet & Arizona	65,246	4,981	5,132	4,591	3,665	3,550
Magma	19,118	1,338	1,377	1,168	1,068	1,178
Miami	29,569	2,882	2,609	2,807	2,564	3,081
Nevada Cons.	133,140	.....	(d) 27,543	.....	.....	.....
Old Dominion(a)	11,172	1,041	830	955	843	885
Phelps Dodge(b)	111,026	7,849	8,200	7,188	6,037	6,048
United Verde Extens.	29,669	2,388	2,371	2,223	1,869	1,681
Utah Copper	148,312	.....	.....	.....	.....	.....
Tennessee Copper	7,870	710	705	713	659	672

Foreign

Andes Copper	83,718	5,627	5,634	4,779	.....	.....
Braden	88,155	6,768	6,766	4,519	.....	.....
Boleo, Mexico	13,196	.....	(d) 3,542	.....	.....	(d) 3,537
Bwana M'Kubwa	6,988	459	598	612	659	556
Chile	150,247	8,746	8,743	7,492	.....	.....
Furukawa, Japan	17,767	1,478	1,552	1,308	1,604	.....
Granby Cons., Canada	30,424	2,525	2,345	1,985	1,791	1,726
Howe Sound	21,516	.....	.....	.....	.....	.....
Messina	(c) 7,200	519	588	641	554	655
Mt. Lyell	7,600	773	624	.....	.....	(d) 3,035
Sumitomo, Japan	20,180	1,719	1,612	1,396	1,207	.....
Union Miniere, Africa	149,872	.....	.....	.....	.....	.....

(a) Includes Arizona Commercial. (b) Moctezuma is included. (c) Estimated (d) Three months.

Monthly Production of Primary Copper from U. S. Mines and Daily Rate (Short Tons)

	1928 Monthly Production	1928 Daily Rate	1929 Monthly Production	1929 Daily Rate	1930 Monthly Production	1930 Daily Rate
January	68,469	2,209	86,324	2,785	67,838	2,188
February	67,423	2,352	84,735	3,026	59,196	2,114
March	70,327	2,269	93,698	3,023	61,091	1,971
April	69,721	2,324	94,902	3,163	.....	...
May	73,729	2,378	93,392	3,013	.....	....
June	73,224	2,441	82,354	2,745	.....	....
July	73,426	2,369	79,229	2,556	.....	.....
August	76,952	2,482	78,885	2,545	.....	.....
September	78,341	2,611	79,402	2,647	.....	.....
October	86,480	2,790	82,575	2,664	.....	.....
November	85,382	2,846	75,934	2,531	.....	.....
December	85,677	2,764	74,772	2,412	.....	.....
Total	909,051	.....	1,006,203	.....	188,125	.....
Monthly average	75,754	.....	83,850	.....	.....	.....
Av. of daily rate		2,484	.....	2,757	.....	2,090

Mining Share Prices—Month of April, 1930

Company Name	Metals Produced	Location of Properties	High	Low	Last
NEW YORK STOCK EXCHANGE					
Ahumada Lead	Lead, silver	Mexico	1.50	1.00	1.00
Alaska Juneau	Gold	Alaska	8.25	7.00	7.00
Am. Metal	Lead, silver, zinc	Various	51⅛	41	42
Am. Metal, pfd	Copper, gold	Various	115⅝	112	112
Am. Sm. & Ref	Lead, copper, silver	Various	79⅛	68⅛	68⅛
Am. Sm. & Ref., pfd.	Gold, zinc	Various	141	140	140⅛
Am. Zinc., L. & S.	Zinc, lead	Various	16⅜	11	11⅛
Am. Zinc, L. & S., pfd.	Zinc, lead	Various	73½	69	69
Anaconda	Copper, zinc, silver	Various	81⅛	58	60
Andes Copper	Copper, silver	Chile	37½	26⅛	26⅝
Butte C. & Z.	Manganese, zinc	Montana	4.00	3.00	3.00
Butte & Superior	Zinc, silver	Montana	4.00	3.00	3.00
Callahan Zinc-Lead	Lead, zinc	Idaho	1.62½	1.25	1.25
Cal. & Arizona	Copper, gold, silver	Arizona	83¼	64½	64⅛
Cal. & Hecla	Copper	Michigan	30	18⅛	18⅛
Cerro de Pasco	Copper, silver, lead	Peru	64⅜	52⅛	54⅛
Dome Mines	Gold	Ontario	8.87½	8.37½	8.37½
Federal M. & S.	Lead, zinc, silver	Idaho,	185	170	170
Federal M. & S., pfd.	Lead, zinc, silver	Tri-State	100	99⅜	100
Freeport Texas	Sulphur	Texas	55½	45	50⅛
Granby Con	Copper, silver, gold	Brit. Col.	59⅛	33	33⅜
Greene Cananea	Copper, silver, gold	Mexico	89	89	89
Homestake	Gold	So. Dakota	77½	75	76¼
Howe Sound	Copper, lead, zinc	Various	40½	30½	30½
Inspiration	Copper	Arizona	30¼	17⅜	18⅛
International Nickel	Nickel, copper	Ontario	44⅜	34¼	34⅜
Int. Nickel, pfd.	Nickel, copper	Ontario	123	118½	123
Kennecott	Copper, gold, silver	Various	62	44½	45½
McIntyre-Porcupine	Gold	Ontario	19⅛	18⅛	18⅜
Magma Copper	Copper, silver, gold	Arizona	52	33⅜	34
Miami Copper	Copper	Arizona	33⅜	20½	20½
Mother Lode	Copper, silver	Alaska	2.00	1.75	1.75
National Lead	Lead, zinc	Various	173	148	148
National Lead, pfd. A	Lead, zinc	Various	141	139	141
National Lead, pfd. B	Lead, zinc	Various	119	117	118
Nevada Con	Copper, gold, silver	Various	31⅛	20	20½
Park Utah Con	Zinc, silver, lead	Utah	4.37½	2.87½	2.87½
Patiño M. & E.	Tin	Bolivia	23⅜	20	20
Phelps Dodge	Copper, gold, silver	Various	44⅜	35	35⅜
Rand Mines	Gold	Africa	37	34	37
St. Joseph Lead	Lead, zinc, silver	Various	54⅜	44	44
Seneca Copper	Copper	Michigan	3.00	2.00	2.00
Tennessee C. & C.	Copper, su. acid	Tennessee	17	13⅞	14⅛
Texas Gulf	Sulphur	Texas	65½	60⅜	60⅞
U. S. S. R. & M.	Silver, gold, lead	Various	36½	29¼	29⅜
U. S. S. R. & M., pfd.	Zinc, copper	Various	51⅛	48	48
Utah Copper	Copper, gold, silver	Utah	195	190	190
Vanadium Corp	Vanadium, ilmenite	Various	143¾	103	133¾
NEW YORK CURB EXCHANGE					
Aluminum Co. of Am.	Aluminum	Various	356	335	335
Alum. Co. of Am.,pfd.	Aluminum	Various	109	107¾	109
Anglo-Chilean Con	Nitrate	Chile	41	28	34⅛
Bunker H. & S.	Lead, silver, zinc	Idaho	69	65⅛	69
Carnegie Metals	Silver, gold	Mexico	8.50	7.00	7.00
Con. Coppermines	Copper, gold, silver	Nevada	7.75	5.50	5.50
Copper Range	Copper	Michigan	16½	13	13
Cresson Con	Gold	Colorado	0.37½	0.31¼	0.31¼
Cusi Mexicana	Lead, zinc, silver	Mexico	1.50	1.12½	1.25
Evans-Wallower	Lead, zinc	Various	4.75	3.62½	4.00
Federated Metals	Trading	Various	24	21	21⅛
Hecla Mining	Lead, silver, zinc	Idaho	13⅜	12⅛	12⅛
Hollinger Con	Gold	Ontario	7.00	5.62½	6.25
Hudson Bay M. & S.	Copper, zinc	Manitoba	12⅞	8⅜	9⅜
Iron Cap Copper	Copper, silver, gold	Arizona	2.87½	2.00	2.00
Mayflower Assce	Holding	Various	68	60⅞	65⅛
Mining Corporation	Silver, lead, zinc	Canada	2.75	1.62½	1.75
New Jersey Zinc	Zinc, lead, silver	Various	89⅜	80	80
Newmont Mining	Holding, copper, gold	Various	141⅞	114½	114¼
N. Y. and Honduras	Silver, gold	Honduras	12⅜	11	11
Nipissing	Silver	Ontario	1.75	1.50	1.62½
Noranda Mines	Copper, gold, silver	Quebec	40⅜	29⅜	29⅜
Ohio Copper	Copper, lead, gold	Utah	1.12½	0.87½	0.87½
Premier Gold	Silver, gold	Brit. Col.	1.12½	0.87½	1.00
Quincy	Copper	Michigan	45	39	39
Shattuck Denn	Copper, gold, silver	Arizona	9.00	6.00	6.00
So. Am. Gold & Plat	Platinum, gold	Colombia	1.62½	1.37½	1.50
Teck-Hughes	Gold	Ontario	6.50	6.00	6.05
Tonopah Ex	Silver, gold	Nevada	.....	.....	.....
Tonopah Mining	Silver, gold, copper	Various	1.37½	1.12½	1.12½
United Eastern	Silver, lead	Mexico	0.25	0.25	0.25
United Verde Ex	Copper, gold, silver	Arizona	15¾	11⅜	11¼
United Zinc Sm	Lead, zinc	Tri-State	3.00	3.00	3.00
Utah-Apex	Lead, zinc, copper	Utah	3.50	2.75	2.75
Wenden Copper	Copper, silver	Arizona	0.56½	0.37½	0.43¾
Yukon Gold	Gold	Yukon	0.50	0.31¼	0.43¾
BOSTON STOCK EXCHANGE					
Ariz. Comm	Copper, gold, silver	Arizona	1.50	1.37½	1.37½
East Butte	Copper, gold	Montana	1.75	1.12½	1.12½
Isle Royale	Copper	Michigan	11⅛	8.00	9.00
Mohawk Mining	Copper	Michigan	46	35¼	35¼
Old Dominion	Copper, gold, silver	Arizona	9.00	6.50	6.50
Utah Met. & Tunnel	Copper, lead, gold	Utah	0.90	0.51	0.55
MONTREAL					
Asbestos Corp.	Asbestos	Quebec	3.00	2.50	2.75
Asbestos Corp., pfd.	Asbestos	Quebec	14¾	12	12⅛
Consolidated M. & S.	Lead, zinc, silver	Canada	256	225	225

Company Name	Metals Produced	Location of Properties	High	Low	Last
TORONTO STANDARD STOCK AND MINING EXCHANGE					
Abana Mines	Copper, zinc, silver	Quebec	0.94	0.66	0.69
Amulet Mines	Copper, zinc, silver	Quebec	1.47	0.80	0.81½
Base Metals	Lead, zinc, silver	Brit. Col.	3.40	2.50	2.50
Barry-Hollinger	Gold	Ontario	0.19	0.15	0.16½
Canam Metals	Lead, zinc, silver	Various	0.30	0.19	0.20
Castle-Trethewey	Silver	Ontario	0.17½	0.15	0.17½
Central Manitoba	Gold	Manitoba	0.17	0.11	0.12
Coniagas	Holding, silver	Ontario	0.95½	0.80	0.80
Falconbridge	Nickel, copper	Ontario	4.65	2.40	3.25
Howey Mines	Gold	Ontario	0.83	0.64	0.70
Keeley	Silver	Ontario	0.35	0.32	0.35
Kirkland Lake	Gold	Ontario	0.67	0.58	0.64
Lake Shore	Gold	Ontario	23½	22½	22⅝
Sherritt Gordon	Copper, zinc, silver	Manitoba	2.88	1.85	1.93
Siscoe Gold	Gold	Quebec	0.40	0.37	0.37½
Sylvanite	Gold	Ontario	0.59	0.45	0.50
Treadwell Yukon	Lead, zinc, silver	Various	6.25	5.75	5.75
Ventures	Holding	Various	1.90	1.28	1.28
Vipond Con	Gold	Ontario	1.07	0.90	1.03
Waite-A.-M.	Copper, zinc, gold	Quebec	5.00	2.50	2.50
Wright-Hargreaves	Gold	Ontario	2.09	1.72	1.92
ST. LOUIS AND CINCINNATI					
Consolidated L. & Z.	Lead, zinc	Tri-State	5.50	4.75	5.12½
Eagle-Picher	Lead, zinc, silver	Various	13	11⅜	11¼
Eagle Picher, pfd.	Lead, zinc, silver	Various	100½	100	100
SAN FRANCISCO, LOS ANGELES, AND COLORADO SPRINGS					
California Copper	Copper, gold, silver	California	2.00	1.50	1.62½
Golden Cycle	Gold	Colorado	16	15	15½
Idaho-Maryland	Gold	California	0.25½	0.20	0.24½
Portland	Gold	Colorado	0.03	0.01½	0.01½
Tom Reed	Gold	Arizona	0.85	0.75	0.77
United Gold	Gold	Colorado	0.10	0.08	0.08½
SPOKANE					
Constitution	Lead, zinc, silver	Idaho	0.34	0.17	0.27
Dayrock	Lead, silver	Idaho	2.45	1.90	2.00
Golconda	Lead, zinc, silver	Idaho	0.87	0.72½	0.76
Grandview	Zinc, lead	Wash	0.09½	0.06⅜	0.06⅜
Highland-Surprise	Lead, silver	Idaho	.....	.....	*0.06
Jack Waite Con	Lead, zinc, silver	Idaho	0.11½	0.08½	0.09⅜
Lucky Jim	Lead, zinc	Brit. Col.	.....	.....	*0.05
Mexican Premier	Lead, silver, gold	Mexico	0.80	0.66	0.66
Montana Mines	Gold, silver	Montana	0.35½	0.31	0.35
Noble Five	Lead, zinc	Brit. Col.	0.12	0.11½	0.12
Pend Orielle	Zinc, silver, lead	Wash	2.75	1.25	1.25
Ruth Hope	Lead, silver	Brit. Col.	.....	.....	*0.14
Sherman Lead	Lead, silver	Idaho	0.65	0.49	0.49
Silversmith	Lead, silver	Brit. Col.	.....	.....	*0.05
Sunshine Mining	Silver, lead, copper	Idaho	3.80	2.95	2.95
Tamarack & Custer	Lead, silver	Idaho	0.54	0.40½	0.45¾
Whitewater	Lead, silver	Brit. Col.	.....	.....	*0.15
SALT LAKE CITY					
Chief Con	Lead, silver, gold	Utah	1.25	1.10	1.10
Combined Metals	Zinc, lead, silver	Various	0.13	0.11½	0.13
Eureka Bullion	Lead, silver, gold	Utah	0.36	0.28	0.28
Eureka Lilly	Lead, silver, gold	Utah	0.64	0.58	0.58
Moscow Silver	Silver, lead	Utah	1.65	1.02½	1.02½
New Quincy	Lead, silver, zinc	Utah	0.58	0.45	0.45
North Lily	Lead, silver, gold	Utah	2.35	1.97½	1.97½
Park Bingham	Lead, zinc, silver	Utah	0.05	0.03¾	0.05
Park City Con	Lead, zinc, silver	Utah	0.65	0.36	0.40
Rico Argentine	Zinc, lead, silver	Colorado	0.09½	0.07	0.07½
Silver King Coal	Lead, silver, zinc	Utah	10⅜	9.60	9.60
Tintic Lead	Lead, silver, copper	Utah	1.60	1.50	1.50
Tintic Standard	Lead, gold, silver	Utah	9.00	7.40	7.40
Walker Mining	Copper, gold, silver	California	4.30	2.85	2.85
‡LONDON					
Anglo American	Holding	Various	.....	.....	26/3
Aramayo Mines	Tin, bismuth, silver	Bolivia	.....	.....	35/7½
Burma Corporation	Lead, silver, zinc	India	.....	.....	14/—
Bwana M'Kubwa	Copper	Rhodesia	.....	.....	19/—
Camp Bird	Holding	Various	.....	.....	1/1½
Fresnillo	Silver, lead, zinc	Mexico	.....	.....	.....
Frontino & Bolivia	Gold	Colombia	.....	.....	6/3
Lake View & Star	Gold	Australia	.....	.....	11/6
Mexican Corporation	Copper, zinc	Mexico	.....	.....	7/—
N'Changa Copper	Copper	Rhodesia	.....	.....	55/—
Oroville Dredging	Gold	California	.....	.....	1/—
Rhodes. Congo Border	Copper	Rhodesia	.....	.....	300/—
Rhodes.-Select. Trust	Copper	Rhodesia	.....	.....	51/3
Rio Tinto	Copper, pyrites	Spain	.....	.....	850/—
St. John del Rey	Gold	Brazil	.....	.....	18/9
San Francisco Mines	Zinc, lead, silver	Mexico	.....	.....	22/6
Santa Gertrudis	Silver, gold	Mexico	.....	.....	9/9
Selukwe	Holding	Africa	.....	.....	4/—
So. American Copper	Copper	Venezuela	.....	.....	2/4½
Tanganyika	Holding	Africa	.....	.....	41/10½
Wiluna Gold	Gold	Australia	.....	.....	.....
Union Minière	Copper	Bel.Congo	.....	.....	9,250†

Salt Lake Stock Exchange courtesy J. A. Hogle & Company, Toronto Standard Stock Exchange courtesy the Arthur E. Moysey Company, Spokane Standard Exchange courtesy the Pohlman Investment Company. *Not traded in. †Belgian Francs. ‡The above London quotations are closing prices of April 15. In the future, high, low, and last prices for a month will be printed.